The Welding Engineer

Reg. U. S. Pat. Office

Founded by L. B. Mackenzie, 1916

APRIL, 1927 VOL. 12, No. 4

$3.00 per year in U. S. 608 S. Dearborn St., Chicago, Ill. $4.00 per year abroad

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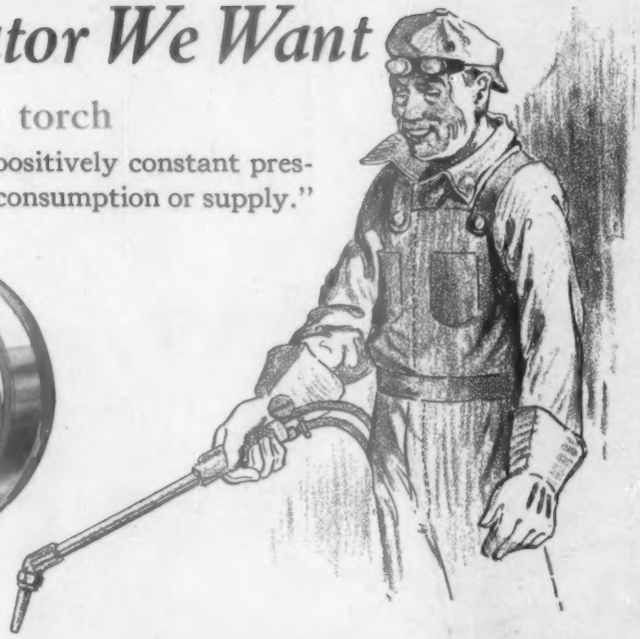

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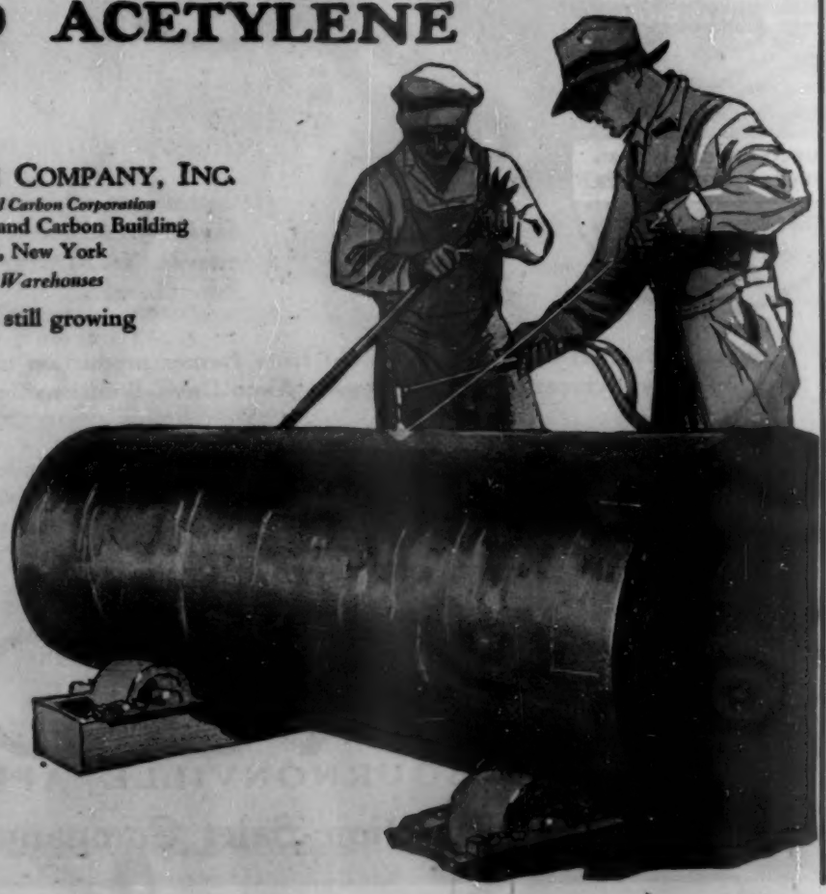

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22 years old and still growing

The Welding Engineer

Founded by L. B. Mackenzie, 1916

Volume 12 April, 1927 Number 4

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Your Research Facilities

AS YOUR interest in the fusion welding processes extends from one application to another, new problems arise in your work. The simplest of them may still be unsolved and the most difficult ones may have been completely mastered. Research laboratories of the leading manufacturers of welding equipment and supplies are not only working on your present problems but also getting ready to solve problems which they see coming up for you in the future. Your research facilities extend far beyond the boundaries of your plant or factory. The men whose duty it is to help you get better satisfaction from welding are willing workers and their activities on a great variety of problems give them the command of a great volume of information which you can use. These pages serve only as a short introduction to the people who are developing new and better methods for you to use. Don't stand on ceremony. Get better acquainted with them and let them exercise their willingness to help.

Published on the 15th of Each Month by

THE WELDING ENGINEER PUBLISHING CO.,
608 S. Dearborn St., Chicago, Ill.
Telephone Wabash 7134

G. H. Mackenzie.....President and Treasurer
M. J. Hungerford.....Vice-President
H. S. Card.....Secretary

H. S. Card.....Editor

Eastern Office—323 American Circle Bldg., New York
T. E. DePew, Eastern Manager
Telephone, Columbus 6941

Cleveland Office—Hollenden Hotel
L. St. Clair Ehlbert, Cleveland Manager

Subscription payable in advance and postage free.
United States and possessions and Canada.....$3 a year
Foreign Countries.....$4 a year
Single copy, domestic.....25 cents
Single copy, foreign.....30 cents

Entered as second-class matter January 20, 1916, at the postoffice at Chicago, Illinois, under the act of March 3, 1879.

The Welding Engineer is a member of the Audit Bureau of Circulations and of the Associated Business Papers, Inc.

Last Advertising forms close at 8:00 a. m. on the 12th. To show proof for correction copy must be received at an earlier date and allowances should be made for delay to mails. All copy should be in by the 12th of the month at the latest.

The Welding Engineer does not publish in its news or advertising columns any matter that deals with or refers to either personal or legal controversies.

Authorized Representatives

CLEVELAND—R. K. Randall, 3200 Prospect Ave.
DENVER—A. G. Odell, Public Opportunity School.
GREAT BRITAIN—Capt. D. Richardson, 39 Red Lion Square, Holborn, London, W. C. I.
AUSTRALIA AND NEW ZEALAND—R. Hill, Matlock House, Davenport, Auckland, New Zealand.
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Buyers' Index

Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.

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Air Reduction Sales Co.
Commercial Acetylene Supply Co.
International Oxygen Co.
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Joseph Dixon Crucible Co.

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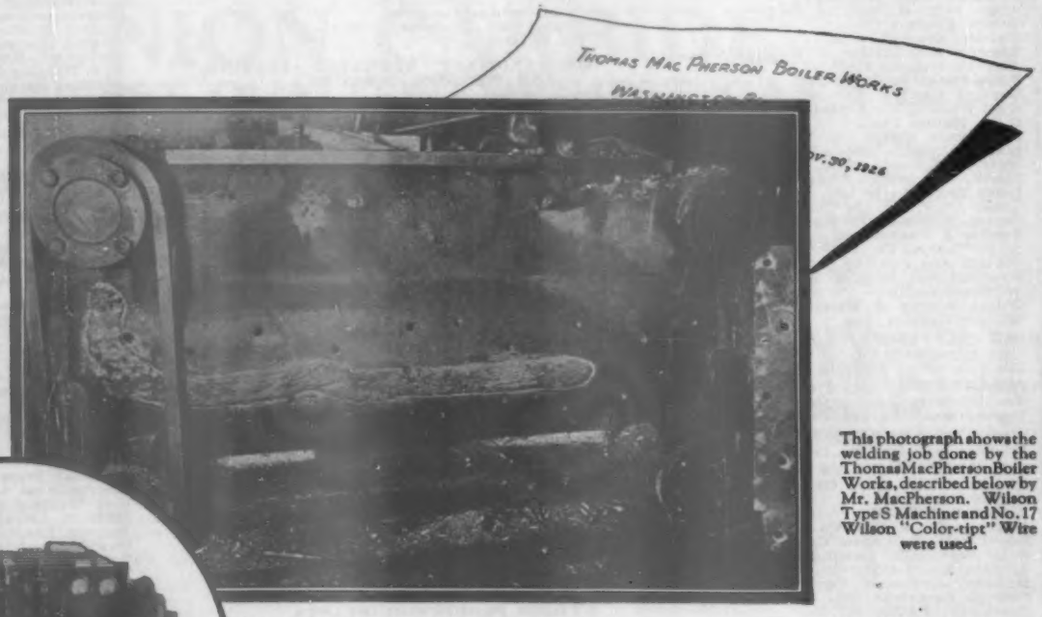
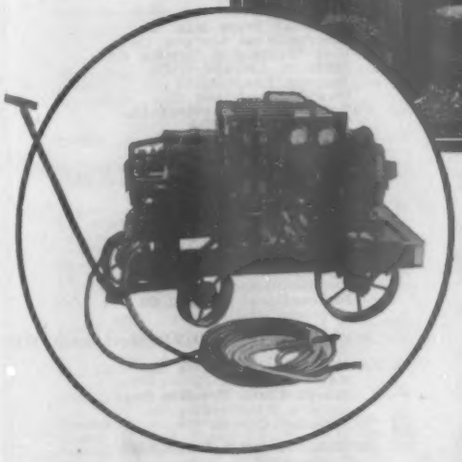


This photograph shows the welding job done by the Thomas MacPherson Boiler Works, described below by Mr. MacPherson. Wilson Type S Machine and No. 17 Wilson "Color-tipt" Wire were used.



The above is a Wilson Type S Single-Operator Motor-Driven Electric Welding Machine—designed for both production and repair work, and adapted for use wherever power is available. Its capacity is 25 to 300 amperes. Other Type S Machines include both single and two-operator units—gasoline-engine-driven, belt-driven and motor-driven—portable and stationary. Capacities: 25-250, 25-300, 25-600 Amperes.

The right grade of wire for the metal, and perfect uniformity and flowing quality in each grade—that's Wilson "Color-tipt" Welding Wire! You can select just the right grade (analysis) for each weld—and every rod will be just like every other rod in the grade you select. Each grade is designated by a color, hence, "Color-tipt".

"The Biggest Welding Job In My Experience!"

"I AM enclosing photograph of the biggest welding job in my experience. The cylinder over all is 8 ft. long and 30 inches in diameter. The horizontal crack is about 6 ft. long; and that weld you see in the picture reaching up the end of the cylinder is 2 ft., making a total of 8 feet. The thickness of the cylinder wall is 1⅛ inches. I am very pleased to tell you the job is a complete success. The Wilson Welding Machine behaved splendidly. And as for the Wilson Color-tipt Welding Wire, I never would have tackled this job without it. As regards the procedure, the crack was first veed out to an angle of 45 degrees, holes drilled and ⅝-in. steel studs inserted at 1½-in. pitch. The cylinder was kept slightly hot."—*T. MacPherson, Thomas MacPherson Boiler Works, Washington, Pa.*

The biggest welding job in my experience! An 8 ft. crack in a steam cylinder. A fussy job. But experience pointed to the *sure* way—a Wilson Machine and the right grade of Wilson Wire.

Are you profiting by the economies afforded by electric welding? And are you making possible the perfect weld? Use Wilson Machines and Wilson Wire—the right grade for the metal you're welding, of course—and the rest is up to the welder. There is a Wilson Welding Machine that meets *your* particular operating conditions—*your* particular industry. And there is a right grade (analysis) of Wilson Wire for the particular metal you are welding.

Send today for bulletins describing Wilson Welding Machines, and ask for sample of Wilson "Color-tipt" Welding Wire, indicating the kind of welding you wish to do.

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SPOT WELDERS
See "Electric Resistance Welders"

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C. Sorensen

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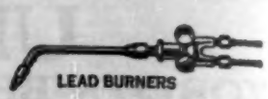
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ARE THE FINEST QUALITY RODS ON THE MARKET TODAY

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Auspices American Welding Society

In Co-operation With

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September 19, 20, 21, 22, 23, 1927

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For complete information, floor plans and rates, write

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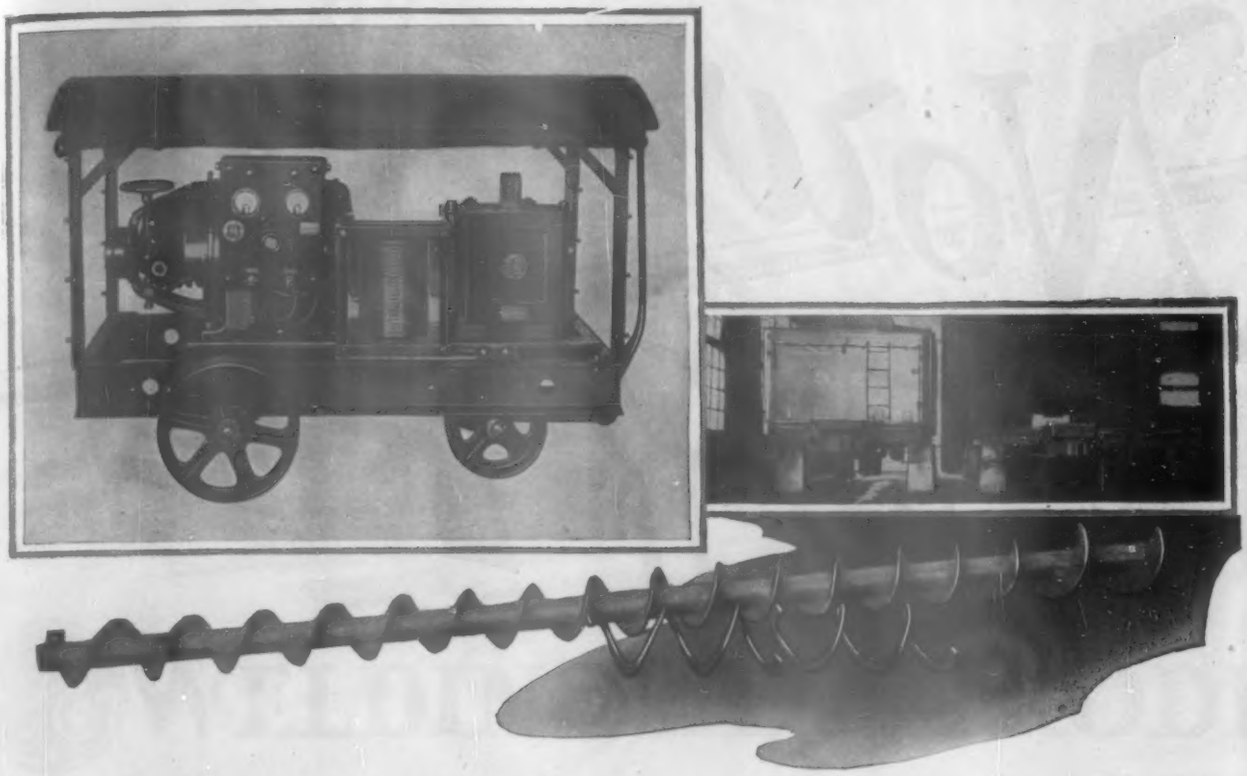

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530-23

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It has stability, uniformity, and produces clean, strong welds.

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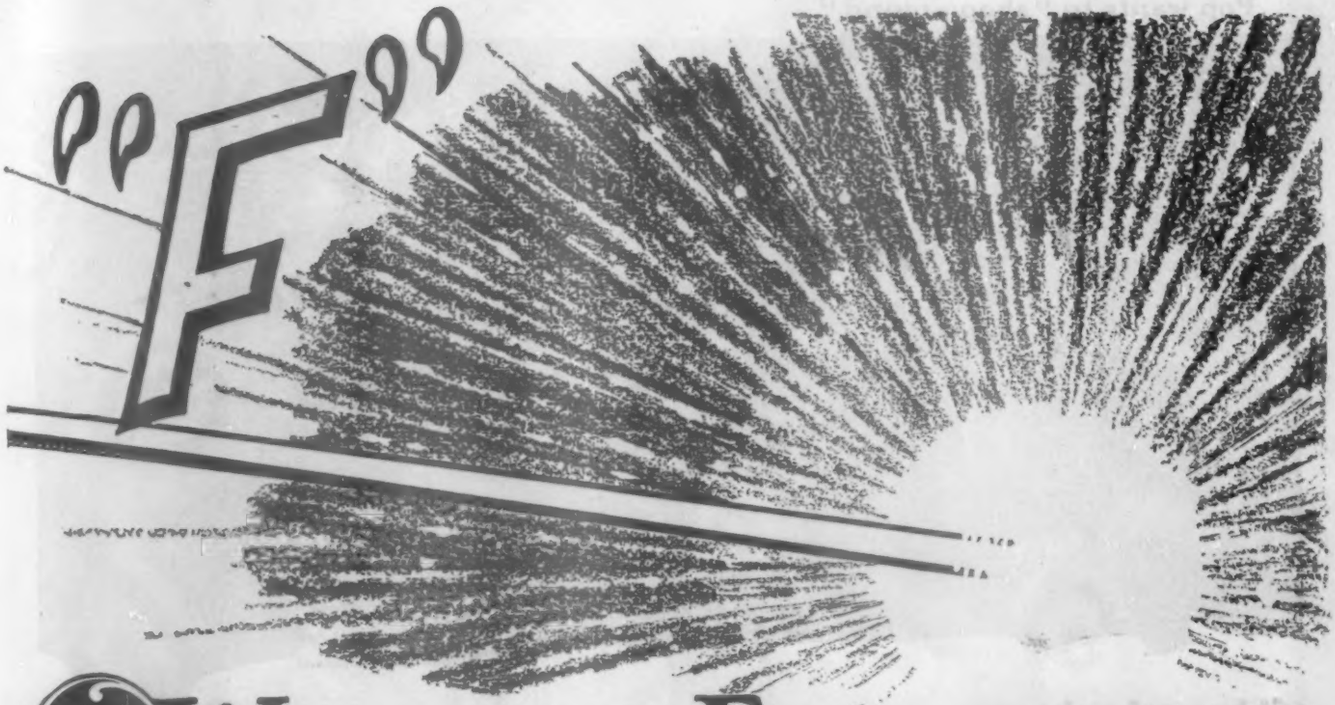

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Its uniformity provides good working conditions continuously.

Clean, strong welds make every job a good one.

The new Type "F", treated by a special General Electric process, costs no more than good, bare welding wire and its economy in use is naturally much greater.

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TYPE "B"
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For general welding of steel.

550-14

ELECTRIC

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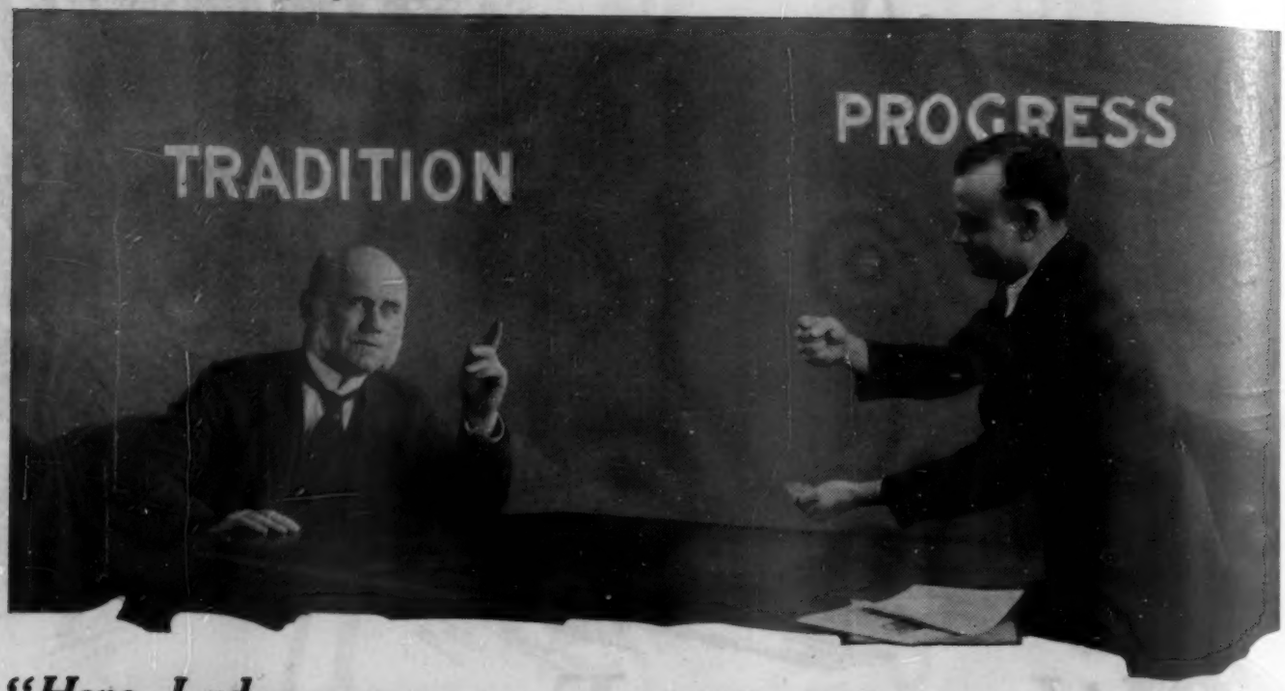

"Here, Lad . . .

we need another welding machine to take care of the new work that starts next month.

This work may be only temporary, so shop around and see whether you can pick up some second-hand welding outfit cheap."

Kathode wire is furnished in the following diameters: 3/32", 1/8", 5/32", 3/16", 1/4", 5/16", 3/8".

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it's a cinch to pick up a cheap welder—and it doesn't need to be second hand.

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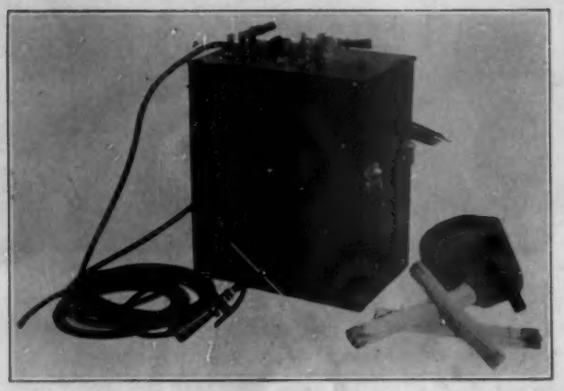
Specify

the

OWEN INDUCTION ARC WELDER



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Fool Proof
No Moving Parts
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Weight of 50 to 150 amp. Welder, approximately 190 lbs.
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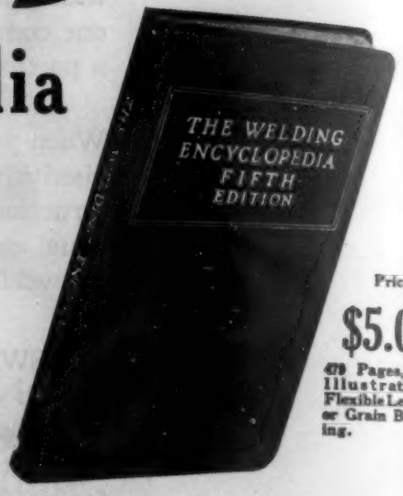
Fifth Edition



Price

$5.00

479 Pages, 625 Illustrations. Flexible Leather Grain Binding.

It describes in detail the theory and practice of every welding process. It tells how to weld every weldable metal by each of the welding processes. It gives detailed instructions for handling the important welding jobs, such as boiler welding, sheet metal welding, tank welding, pipe welding, etc. It tells how to prepare parts for welding. It tells how to install and care for welding equipment. It explains the meaning of all words and terms found in welding literature. It tells where to buy all standard makes of welding apparatus and supplies.

Contents

1. Illustrated encyclopedia covering all words, terms, and trade names used in welding.
2. Oxy-Acetylene Welding.—Aluminum, Steel, Cast Iron, Brass, Bronze. (Full instructions for welding each of these metals.)
3. Electric Arc Welding.—Complete instructions for welding all metals, studding, cutting, etc.
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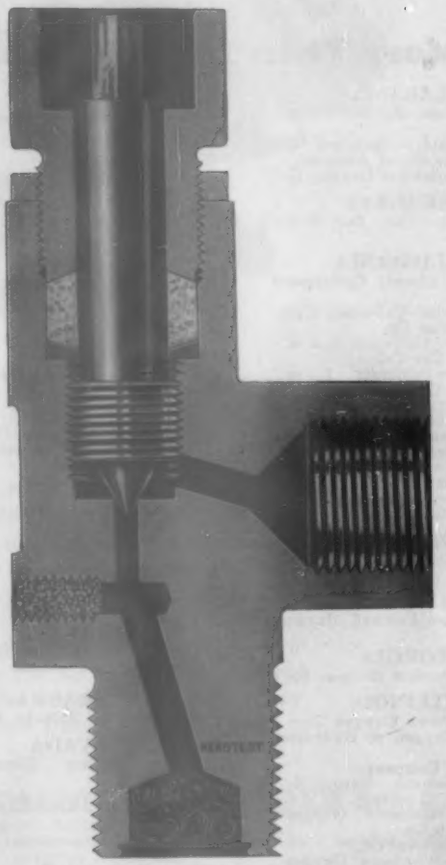

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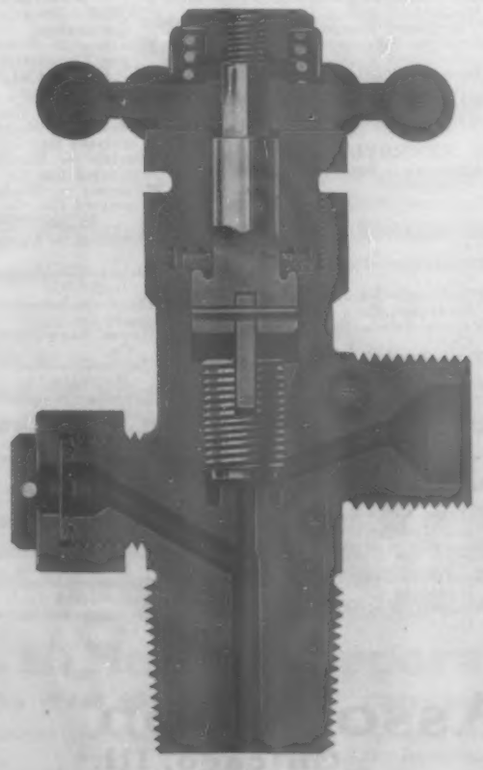

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The HOLLUP ARC WELDER is designed and assembled to produce a WORK-WISE equipment suitable for all ranges of welding work, from the lightest to the heaviest, with maximum efficiency, convenience and economy. Special attention has also been given to insure reliability of operation.

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Welding leads may be disconnected or reversed without touching or exposing any current carrying parts.
No exposed switches or current carrying parts.
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Exceptionally compact design—all controls at one point.
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The welding characteristics of the Hollup Arc Welder are best described by the word "work-wise"—the product of the combined ideas of several of the foremost welding engineers in the United States. The maximum amount of metal can be deposited efficiently for any given class of work, with the least amount of effort on the part of the operator.

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EDITORIAL

Welded Steel Products Reduce Fire Hazards

A SHORT time ago an inquiry was received for information regarding steel doors for residences. A prospective home builder was already making his plans to construct the framework of his house of steel, and incidentally to have it welded throughout; not only on account of the strength and durability of such a structure, with the possibility of a smaller construction cost, but also because he thought of the lightning hazard in a community where fire fighting apparatus was not of the best and most easily accessible, and had brought to his attention the fact that welded steel frames had been pronounced a reliable safeguard against lightning. Further consideration of the fire hazard led him to investigate the possibility of using steel window frames, steel window sash, steel door frames and also steel doors. A study of the experiments conducted in fire insurance laboratories convinced him that he could logically expect to confine a fire to a single room in a residence constructed in this manner, by the simple expedient of closing the doors. This is a good illustration of the results being secured by the co-operative advertising campaign now being carried on by the sheet steel industry. Every possible advantage of the steel products is being given wide publicity both in national advertising media and in direct mail campaigns. Fusion welding makes a generous contribution to the advantages of these products. It simplifies design, it gives additional strength, and it reduces the cost of fabrication. The next question is whether or not the public can be made to like the steel products. Fortunately the welded steel article can be made to take any of the finishing processes now used in production, so that there is a great deal in its favor as far as the matter of appearance is concerned. Manufacturers of these products are wide awake to their advantages but understand very well that these advantages are not matters of public knowledge. Consequently their educational work is as thorough as it is vigorous. And their products are becoming increasingly popular.

Next—All Welded Golf Courses

EVERY welding fan who belongs to a country club should look over the tee boxes on his course when the season opens. The most practical tee box can be made of welded steel. It is a simple matter to weld a partition so as to make one compartment each for sand and water. This removes the temptation for somebody to run away with the water pail. Legs and braces can easily be fabricated of welded angle iron welded to the box itself. A tee box made in this way ought to look just as well and last far longer than the old fashioned wooden tee box with its disappearing water pail. And it would not do any harm to have these welded articles out in places where people can see them and become better acquainted not only with the value of the welded joint but also with the idea that welding can be applied to practically any kind of metal fabrication. Get your country club to install welded tee boxes. Invite your prospective customers out to play golf. Show them how good welding is right after they have run down a long putt. In other words combine business with pleasure.

An Interesting Phase of Laboratory Work

THE importance of research laboratory work in welding is emphasized in a striking way with each report of the commercial application of a new alloy. Just as fast as these alloys are discovered or developed in the metallurgical laboratories, it is necessary that the welding laboratories develop ways and means to weld them. In this era of mass production old methods are cast aside without hesitation and new methods are adopted. The same is true of materials; ordinary mild steel is one of the most popular raw materials. Still, all those who use it are not thoroughly satisfied with it, and metallurgical engineers are constantly coming forward with various kinds of substitutes, some of which contain no iron at all. The substitution may be to secure lightness; to secure additional strength; to secure resistance to corrosion; or reduction in cost of manufacturing an article. There are two reasons why the welding laboratory has to keep up with the metallurgical laboratory. One of these is that it is desirable to be able to continue welding the joint even if the material is changed. The other is that the possibility of welding an alloy may make a considerable reduction in the cost of an article when the raw material has been changed. This gives us a picture of the vital importance of a commercial research laboratory. It not only helps to insure the continued use of welding in production by having that production problem solved in advance, but also makes possible the introduction of the process in factories which have not been able to use it to advantage before new materials were introduced.

Let Steamfitters Learn to Weld

INDICATIONS are that welding has made a favorable start and a favorable impression in the plumbing, heating and ventilating trade. Some of the leading men in these industries have watched with growing interest the progress that has been made in the field of pipe welding. It is well known that welding has been successfully applied to pipe in all of the sizes and all of the shapes that would ever be encountered in the plumbing, heating and ventilating trade. To collect all of the data that is available on the general subject of pipe welding, and classify it in such a way as to make it of the greatest possible service to the industries who are investigating the possibilities of using welding, is only one step in the program of development work which must be carried out in order to secure a more general adoption of the process by these industries. Another step involves securing competent operators. By the time heating and ventilating engineers are sufficiently supplied with engineering data to justify them in a more general adoption of welding in their installations, it will be found that the question of providing suitable operators has been solved in some localities. In the larger cities apprentices in these trades are being trained in trade schools. These trade schools are gradually providing for the future by making welding a part of the apprentice's training. The period of training extends over many months, in some cases over two or three years, and, even though only a small amount of welding instruction is given at a time, the total amount of instruction is enough to give the ordinary young workman a good foundation for being the right kind of a pipe welder by the time he gets ready to go on the job. It is fortunate that this kind of training is going on in the larger cities. When the demand for welded joints in pipe installation increases there will be many cases where it will not be necessary to go outside of the trade to find welders because they will be present in the ranks of the workmen themselves. It should not be difficult to train good pipe welders under circumstances like this. And if welding is made to be naturally a part of their trade they are not apt to have silly objections to the use of the process in their work. The demand for welding in these lines may grow so fast in the next couple of years as to show that after all the start was made a little bit too late. But this would serve as a stimulant to greater interest and greater activity in welding instruction for apprentices. Trade schools already doing this work should be encouraged to the fullest extent, and trade schools who have so far neglected the subject of welding should be encouraged to adopt it and assisted in every possible way to make provisions for instructing the coming generation in the use of the welding torch, so that when their turn comes to actually go to work they will be able to use up-to-date methods. The welding industry has a great deal at stake here. A pipe weld may seem to be a small job but when it is considered that annual expenditures for pipe fitting in this country run into a nine figure total it becomes apparent that large expenditures for welding would result if educational work were carried on successfully.

Oxweld H.T. pays 20%

When you buy welding rods you expect reliability and strength in the welds you make. Oxweld rods have always given you that.

But the Oxweld No. 1 High Test steel welding rod gives a 20% dividend of strength over good grade Norway rods. A remarkable return on any investment.

One company compared hundreds of welds made by its staff of 80 welders with both H. T. welding rods and good grade Norway rods. The tensile strength of the H. T. welds averaged 20% higher! And the welding was accomplished in 20% faster time.

In some measure this explains the remarkable increase in the use of Oxweld High Test rod.

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WELDING AND CUTTING APPARATUS

Panorama of Mt. Tamalpias and the Town of Mill Valley At Its Foot On the Eastern Slope. Muir Woods, One of the Famous Redwood Groves Is Situated In the Valley, At the Left.

Welded Pipe for Water System

Installation Difficulties in Mountainous Country More Than Offset by Superiority of Welded Steel Over Concrete Pipe

By W. P. Brown*

THE territory served by the Marin Municipal Water District comprises practically the whole of southern Marin County, just across the Golden Gate from San Francisco.

The principal towns served are San Rafael, San Anselmo, Fairfax, Ross, Kentfield, Larkspur, Corte Madera, Mill Valley, Belvedere and Sausalito. Water is also barged across San Francisco Bay to supply the California Hawaiian Sugar Refining Co. at Crockett in Contra Costa County. The California State prison at San Quentin is also served.

This water district was formed in 1912 and constructed Alpine Dam, a reinforced arched structure 108 feet high, in Lagunitas Canyon on the western slopes of Mount Tamalpias. This peak rises over 2,500 feet above sea level and is part of a chain of mountains of the Coast Range about 15 miles from the Pacific Ocean.

As the rainfall is over three times as great on the western slopes as on the eastern slopes where the towns served are situated, the problem was to catch the water on the western watershed and transfer it to the eastern slopes.

This was accomplished by building Alpine Dam on the western slopes in Lagunitas Canyon, taking the water down the canyon three and a half miles by pipe line, then through a tunnel 9,000 feet long, and then down the Cascade Canyon three and a half miles by pipe line on the eastern slope to Phoenix Lake, a reservoir at a high elevation, and from there through a distributing system to the various towns.

The original pipe line in these canyons was a concrete line 30 inches in diameter and was made up of four-foot sections and cemented together by bell and spigot joints.

This line gave a great deal of trouble in leakage and breaking from land slides and the Marin Municipal Water District decided to install a parallel line made of steel with all joints welded and make it a pressure line.

The steel line consisted of 30,000 feet of 26"x¼" and 7,200 feet of 30"x¼" pipe.

The general contract for the manufacture and installation of the line was taken by the Western Pipe and Steel Company of San Francisco and this company sublet the welding of the field joints and the installation of the line to Brown Bros. Welding Co., of San Francisco.

The pipe was fabricated at the South San Francisco plant of the Western Pipe and Steel Co. All longitudinal joints were

Welding Joint. Note Trucks Close to Line to Clear Narrow Road.

welded with General Electric full automatic arc welding machines. The pipe was hot dipped and put into a machine and rotated and a soil-proof covering spirally wrapped on the pipe with a hot asphalt composition. One foot on each end of the pipe was left free from wrapping to accommodate the welding of the field joints.

The pipe was then barged 25 miles up the bay to San Rafael, hauled up the mountain by large auto trucks and yarded where

*Brown Brothers Welding Co., San Francisco, Calif.

possible, and from there hauled in on the mountain ledge by small trucks and deposited along the ditch where possible. Where it was not possible to land the pipe along the ditch for want of room, it was hauled in as the welding gangs needed it.

The installatoin of the line presented many difficulties due to the crookedness of the line, contour of the country and lack of room on the ledge and also due to the fact that the line was installed within a few inches to two feet of a concrete line and

Showing 26" Pipe On Trestle At Head Of Gulch Before Lowering.

the ditch had to be dug for the greater part in solid rock. The roadway had to be kept clear and no mechanical means could be used in handling the pipe for want of room. All pipe had to be moved and placed by hand.

The ditch was dug by the water district and it called for some very skillful blasting; even then it was necessary at times to build the steel line around stumps and rocks which could not be blasted without danger of wrecking the concrete line.

At the heads of gulches, the lines crossed a good many concrete

Close Quarters Of Concrete and Steel Lines In Tunnel.

trestles and at one point the steel line dropped into a syphon 150 feet deep with very steep sides, there being 700 feet of pipe in the syphon.

Ordinary pipe line methods could not be used, and to overcome the handicaps, Brown Bros. Welding Co. developed several devices which made it possible to install the line complete in four months.

The pipe was made in fourteen-foot lengths, and due to the crookedness of the ditch, it meant even with these short lengths that every joint had to be mitered to some angle varying from one degree to a maximum of twenty-eight degrees. This angle had to be determined by stretching a string down the ditch for the next length of pipe and reading the angle required on a protractor, which was held on the side of the last length welded.

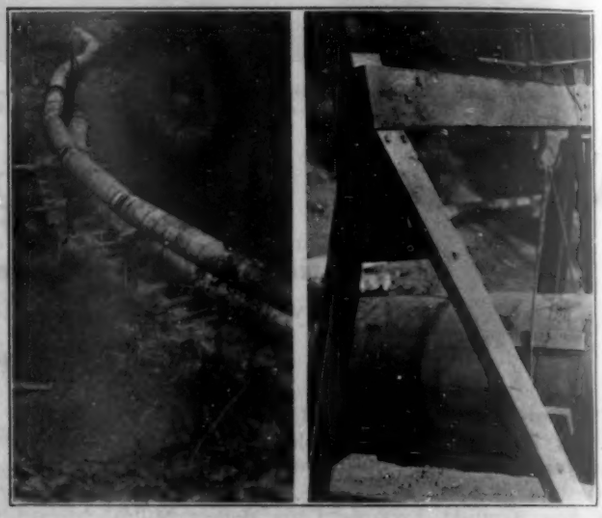
This angle had to be accurately cut because the ditch was only 36 inches wide and at places 10 feet deep.

Old methods of laying out miter cuts could not be used because of the time required. This handicap was overcome by the development by Brown Bros. Welding Co. of an internal mitering machine by which it was possible to set up in the end of a pipe and miter, cut and bevel to a 45-degree scarf at the same time. This total time was about ten minutes per end, the actual cutting time being from four to four and a half minutes per end of pipe.

This cutting machine left the end of the pipe beveled for welding and as true as ordinary mill bevel end pipe. About 5,500 ends of pipe were mitered and beveled in this manner in the field.

Powerful internal expanders were also developd for this job by which the joint was squeezed into perfect alignment very rapidly without any one going into the pipe. The expander could be left holding the joint during the welding operation, or, the joint could be tacked and the expander moved ahead to align the next joint while the last one was being welded.

Then came the problem of welding the line. Bell holes could



Left—26" Pipe Ready For Lowering. It Was Impossible To Get a View Of More Than Four Of These Horses At One Setting Due To the Line Disappearing Around the Bends.
Right—Lowering Horse With Full Load. Note Boards To Protect Pipe Covernig From Being Cut By Cable.

not be dug because of the proximity of the concrete line. Stakes could not be used and laid across the ditch because a great deal of the outside ditch had only one side and the pipe rested on a narrow ledge 36 inches or so in width and on the inside ditch; the grade of the ditch did not conform to the grade of the roadway.

To meet this obstacle, special collapsible horses were made, the tops of which were 40 inches from the bottom of the ditch for most of the line. For deep cuts higher horses were made.

This procedure made it possible to collapse the horses, remove them in two parts out between the pipe and narrow ditch and move them ahead and set them up again.

Then came the problem of lowering the pipe. This was overcome by making special ball bearing lowering screws 5 feet long of 10 tons capacity so that a man could easily lift 5 tons with one hand at the end of an 18-inch handle on the nut, or hub.

Wire rope slings were made and special collapsible and adjustable horses were constructed for supporting the lowering screws. These lowering horses were placed from 100 to 150 feet apart and in this way from 1,000 to 2,000 feet of welded line was suspended, the collapsible welding horses removed and the line lowered continuously from one end after the joints had been tarred and wrapped.

Two tunnels, each some 700 feet long, were encountered and they were so small that there was just room for the concrete line and the steel line to lay side by side.

All field joints were acetylene welded, tank gas being used because there was barely room for tank trucks on the narrow ledge.

In very deep cuts the pipe was welded on high horses, lowered to the 40-inch level and tied into the line and then the whole line lowered to the bottom of the ditch. Advantage was taken of the trestles at the heads of the gulches and most of the tie in welds

Internal Expander Ring Set Up In Ring, Showing Wheels On Which It Rests When Collapsed For Rolling In and Out Of Pipe. It Is Expanded or Collapsed By Rotating Center Shaft.

were made at those points which practically eliminated bell holes from the job.

Expansion joints were installed on the trestles, but it was found later that they were not necessary due to the crookedness of the line. In fact, it was necessary to weld tie clips made of heavy angle irons to the line on each side of the expansion joints and install a 1¼-inch tie bolt to keep the ends of the pipe from slipping out of the joint during the test.

Mitering Machine Set Up In End Of 26" Pipe Ready To Mitercut It To Required Angle.

After the installation of the syphon, angle rings were electric welded at various points on the pipe and concrete anchor piers poured to secure it against surges.

The inspectors from the Marin Municipal Water District were constantly on the job at the mill and in the field and they cut out test coupons out of the pipe at will.

The automatically welded longitudinal joint test pieces cut out by the inspectors all developed over 100 per cent in tension, the plate usually breaking about 3" to 4" from the weld. The bend specimens stood 180 degree test very satisfactorily.

The specifications for the field joints called for a minimum of 40,000 lbs. per square inch and a bend test of 90 degrees on the specimens cut from the field welds.

All specimens taken exceeded these limits, which is very good considering the difficult position in which some of these welds were made, every weld being a stationary weld. Two welders were used on each joint, working opposite.

The line was tested at 100 lbs. hydrostatic pressure when completed and was tight.

The only test given the welders at our shop for this job was to watch them weld 6 inches of pipe joint overhead and then cutting out specimens and giving them a vise bend test. It was not necessary to discharge a single welder in the field on account of poor work.

The gas welding equipment was furnished by the National Welding Equipment Co., which has been manufacturing a complete line of gas welding equipment under its own patents for many years. This company is a subsidiary of Brown Bros. Welding Co.

The field electric welding was done by a General Electric unit mounted on a Fordson tractor, being one of the many units operated by Brown Bros. Welding Co. for marine work.

When you consider that 18 months was the calculated time for a draftsman to detail the joints for a riveted construction for this line you can visualize the tremendous saving of time and money by using the welding process over the riveted method besides getting a far superior job. It looks to us that it will be but a short time until all pipe lines, large and small, will be welded.

WELDING MAKES NEW TIES OF OLD RAILS

A novel method of using the electric welding process for converting junk material into something really useful is related in a recent issue of the Iron Trade Review. Engineers of the General Electric Company and of the Delaware and Hudson Railroad collaborated in a test of the possibilities of making railroad ties out of old rails. For the purpose of this test a number of sample ties were installed by the road about a year ago. Two pieces of rail are used for each tie. The rail used is rail which has been removed from the road bed and is so worn that it has been condemned as having no value except its scrap value. Two lengths of rail are fastened together at each end by welding in position the L-shaped angle bars used in ordinary rail joints. This method of fastening prevents the movement of the ties in any direction in the ballast. The ties are fastened to the track by means of a special clamping device which cannot slip out of place. The edges of the tie plate are placed over the center of the top plane of the tie bars so the wave action of the rail throws the load directly over the web of the tie beams instead of on the outer edge of the flanges. This construction is said to reduce the number of rail clamps required to a minimum. The cost of the ties that are made in this manner is slightly in excess of the cost of wooden ties if the scrap value of the rail used is charged to the construction, but since the actual cost of fabrication of the metal tie designed in this fashion is only about 60c and the cost of the wooden tie will average about $2.80 there is really a good sized balance in favor of the welded steel tie since its scrap value always remains. It is pointed out that the application of this style tie has been confined to yard and siding service, but this field alone requires over thirty million ties a year for replacement.

LIMIT OF SAVINGS NOT YET REACHED

In a paper that was recently published on the subject of street railway maintenance work mention is made of the importance of welding of special track work, particularly on manganese steel. One street railway started the use of high manganese electrodes running from 11% to 14% manganese in 1921 and report that they have been uniformly successful from the start. In this work care was always taken to treat the weld while still red hot with cold water, care being taken to see that the parts to be welded be cleaned thoroughly, also to peen the weld after quenching with a small hammer to remove the scale before proceeding to add more metal. A special grade of high carbon rod is also used for welding high carbon on battered rail ends and frogs and this work is spoken of as having improved results. Flux coated rods were used for all of this work. Special mention of the manganese welding is made and it is stated that it has greatly increased the life of special track work, some welds made six years ago still being in service. It is further stated that the limit for producing savings has not yet been reached.

Redesign Engineering

A Means of Stimulating the Growth of Established Metal Making and Using Industries, Through the Use of Fusion Welding and Cutting

By J. B. Green, M. E.*

THE subject matter of this article gives such an unusual view of modern industry that, unless it is read clear through and fully comprehended, it might be mistaken for a poor attempt at humor instead of being recognized as of serious import. It is so serious that industries failing to recognize it will fall by the wayside under the pressure of competition which everyone realizes is daily becoming keener. The managers of such fallen industries will, as usual, blame everybody but themselves.

It is difficult to take seriously the suggestion that there is a connection between the growth of yeast cells and modern metal working industries. About the only connection that might occur to the American executive is a round-about one via the "Home Brew" route, with its consequent irregular attendance of workmen and others. As a matter of fact, there is nothing facetious in the suggestion. The connection is more than close; there is an identity. It is easy to understand and, once fully comprehended, is still easier to apply. Merely because the idea appears strange is no excuse for not investigating it. Before coming to the point, a few preliminary remarks are necessary.

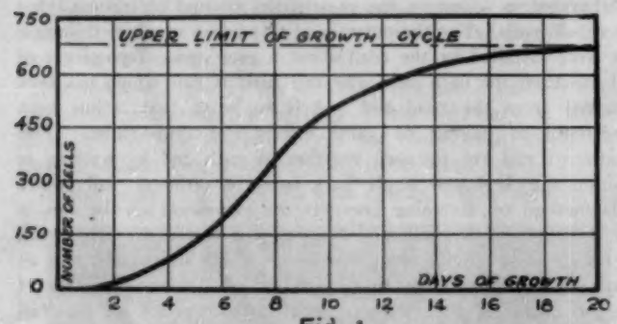


Fig. 1.
Curve of Yeast Cell Growth (Prof. Pearl)

The store of knowledge in possession of mankind is increasing much like the rolling snowball. The present daily additions to this store are probably greater than the additions of a decade or possibly a century during the period preceding the Christian era. There are very many scientific and technical societies and scores of university and industrial laboratories reporting through numerous journals, making this knowledge available. Knowledge is power only if it be used. This article attempts to show what a tremendous store of power the knowledge available today represents when applied to industry, and still further points out that the more highly an industry is apparently developed, the greater the possible benefit. New knowledge is new blood to an industry. It is vital to know the law of growth of an industry and the effect of new blood.

Growth Curves

Strange to say, scientists have discovered that the growth curve of such elemental life as the yeast cell represents the law of growth of all life, including man, the most complex example, and of all industry dependent on man. This law permits evaluating what growth will take place without new blood and what greater growth will occur if new blood is introduced. As yeast cells are bloodless, the biological term "strain" will be used in the discussion. This is merely a necessary shift in language without a shift in significance. In Fig. 1 is shown the growth curve for a strain of yeast cells. Note that, as time passes, they multiply slowly at first, then with increasing rapidity, and finally further growth ceases. Growth here is represented by increase in the number of cells, so that when growth is said to cease, the number of new cells formed in a given time is exactly equal to the number that die. The general form of this growth curve never changes, but its exact shape will vary with each strain of yeast cells studied. Greater or less virility will elevate or depress the maximum growth attained. Greater or less activity will cause the curve to rise more abruptly or less abruptly. A moment's study of the curve in Fig. 1 will indicate the various changes of shape possible, due to changes in both virility and activity which may occur without changing the general form of the curve. Now suppose that a new strain of yeast cells is introduced at some point along the growth curve of another strain. For example, select the point A in Fig. 2. If the new strain is sufficiently virile and active the number of cells representing maximum growth will be far in excess of that possible for the original strain to reach. However, at first the new strain will retard the growth. If the growth had been allowed to continue until the point B were reached in Fig. 2, and a new strain then introduced, the growth curve would continue on up as shown. It is easy to conceive that the cells of a new strain might be larger or smaller or otherwise differ so that there would occur at the point of introduction a vertical rise or fall as illustrated in Fig. 3.

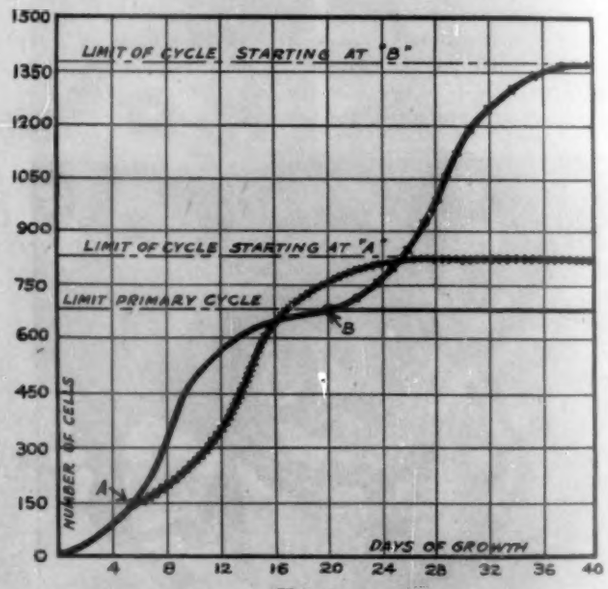


Fig. 2.
Effect on Yeast Cell Growth by introducing new Strains at Points "A" or "B" (Green)

If we stop to think of our own life experiences, each one of us will realize that our own growth has followed a curve of the same form as that representing the growth of yeast cells. The older we are, the more of this curve we can personally trace. Furthermore, we will find it true whether we consider our physical growth, our mental growth, or our growth as measured by accomplishments. Many of us can also attest to the fact that our growth curve has been changed in some one of the ways illustrated by the introduction of new strains in connection with

*President, Fusion Welding Corporation.

yeast cell growth. Possibly this has been brought about by a serious illness, a change of occupation, marriage, an inheritance, a change of environment either social, commercial, or climatic, and the like. Curves plotted showing the growth of cities invariably assume the same form as those for the yeast cells. The growth curve for the city of Chicago is shown in Fig. 4. Nations follow the same curve of growth. The recent world war caused a break in the growth curves of many nations and much of what might otherwise be mystery to the man speculating on international commerce will almost immediately become clear in the light of these growth curves. For example, Russia seems to have exchanged a more or less beneficent autocracy for one at least not quite so beneficent. England remains much as she was. Germany has exchanged a beneficent autocracy for a democracy and the new blood so introduced may result in her defeat in arms becoming an economic triumph.

The growth curves used to illustrate this article are available through the courtesy of Babson's Statistical Organization, Babson Park, Mass. The publications of this remarkable organization have really pointed the way to a clear understanding of the significance of Redesign Engineering. Like individuals or corporations who appear before the public as prophets, Babson's

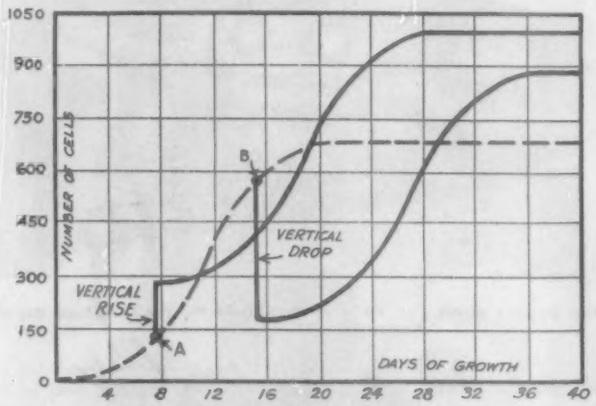


Fig. 3
Curve of Yeast Cell Growth Illustrating Vertical Rise or Drop (Green)

have their devotees and their critics. The author is more inclined than not to disagree with many of Babson's prophecies, but this is quite likely due to his ignorance or inability to understand. The organization deserves the highest praise for the work done in teaching the American public the laws of economics and their workings. These laws are as inviolate as the laws of gravitation, and ignorance of them no more inhibits their action than ignorance of gravity prevents a weight dropped on the foot from causing pain.

A close study of the growth curves of the various industries as shown in Fig. 5 may be the means of avoiding financial pain. Every industry cannot be represented among these curves, but the growth curves of related industries will probably, in many cases, approximate the ones used to illustrate. These industries represent items that go to the home, the farm, and the factory. Before discussing the exact means of altering the growth curve of an industry, some remarks on the significance of sales prices are necessary to make the matter clear.

Connection Between Growth and Selling Price

A conscientious sales manager considers it prime among his duties to maintain the selling price on his goods. If he makes a lower price than his competitor, he realizes that either his goods or his salesmanship or both must be inferior. All too many are apt to stop with this laudable thought. There is something besides direct competition that should be considered in the setting of sales prices. Most of the metal and the articles made from it in this country are manufactured by corporations. These corporations exist for the purpose of showing the stockholders the highest possible return on their investment. The dollars earned per share of capital stock should be the sales manager's guide. His price policy should be examined from this standpoint. For example, if cutting the sale price of an article increases the company's earnings per share of stock, it is the proper thing to do regardless of whether or not the price cuts under that of a competitor.

More often than not, the producer's real competition comes from what the sales manager would call non-competing lines. The salesman may learn to dislike his direct competitor because he rightfully or not considers him the cause of losing an order. As a matter of fact, the automobile competes with the radio, jewelry with fur coats, and, probably due to the prevalence of installment buying, all these so-called luxuries compete even with such necessities as food and lodging. Regardless of how many

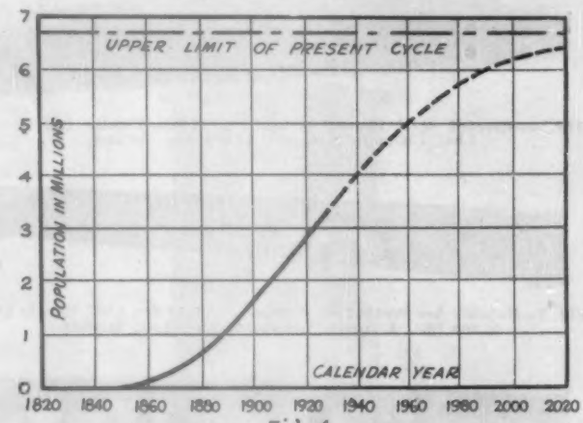


Fig. 4
Growth Curve for City of Chicago (Babson)

times an article is sold and resold, or converted and reconverted, the ultimate consumer is the only real customer. He pays all the labor and material costs, all the profits, all the taxes. When he rides on a railway train, for example, he not only is paying for the direct charges of operating the train, but he is paying his proportion of the labor, material and profit on the locomotive, the machine tools used for manufacturing the locomotive and so on back.

An examination of the income tax returns to determine the number of individuals in each income class throws a great deal

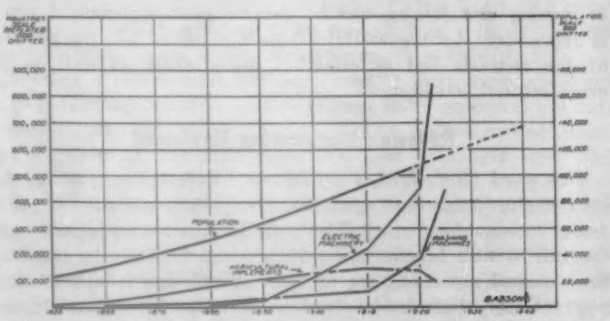


Fig. 5—Industrial Growth Curves.

of light on the subject. An analysis of these statistics indicates that for every one per cent reduction in the selling price of an article the number of prospective purchasers is increased from five to ten per cent. This means that, if the selling price of an article is cut in two, the number of possible purchasers is increased from two and a half to five times. This increase is, of course, one of opportunity only. The additional prospective customers must still be sold. The real thought to gather from these remarks is that there are very few persons with large incomes and very many with small incomes, and that, if all these persons

were arranged in successive layers, those with incomes of $1,000 in the first, then immediately above them, those of $2,000, and so on, a pyramid would be formed, tapering quickly to the top. There are only about a quarter of a million persons with incomes over $10,000, but nearly three-quarters of a million over $5,000, and a million and a quarter over $4,000, while there are seven million individuals in the United States with incomes over $1,000.

This article does not purport to be a treatise on economics, so no attempt at a complete economic discussion will be attempted. Only enough along such lines will be said to point the way to further study and thought. The real object of the article is to indicate the significance of introducing new blood into an industry and to show one specific way in which this may be accomplished. There are all sorts of new blood which may be introduced into an industry, but among the most potent is that kind

Fig. 6—Riveted Steel Beam. Weight, 798 Lbs.—Elastic Limit, 60,000 Lbs. Ultimate Strength, 74,000 Lbs. (Candy.)

Fig. 7—Metallic Arc Welded Steel Beam. Weight 656 Lbs. Elastic Limit, 65,000 Lbs. Ultimate Strength, 78,000 Lbs. (Candy.)

Fig. 8—Metallic Arc Welded Steel Beam. Weight, 795 Lbs. Elastic Limit, 60,000 Lbs. Ultimate Strength, 110,350 Lbs. (Candy.)

which results in so substantially reducing costs that lower selling prices become practical, and, if quality can be raised at the same time, so much the better. Lowering the selling price, as already pointed out, increases sales opportunities, which far more than offset the reduction and, when margins of profit are maintained, earnings on invested capital are increased. Of all the modern developments which are available as sources of new blood to the metal making and using industries, probably none is so potent as fusion welding. It not only is an economical means of cutting and joining metals, but its most important function is represented by the facilities which it offers for the redesign of the methods and materials of manufacture as well as the manufactured article itself.

Redesign Engineering Explained

This word "Redesign" is a new one. Redesign engineering has been employed time and again, but always in a sporadic way incidental to something else. The issue is thus always clouded and the full possible benefits are seldom realized. Only by attacking the technical aspects of the problem of redesign from the standpoint of the economics involved, as indicated in this article, and then carrying the matter to a conclusion, can substantial progress be made. It should be clear that redesign must never be confused with the overworked word "efficiency." Redesign introduces new blood, starts the whole industry off again on an era of new growth, and, after the redesign work has been done, then the efficiency engineer may properly step in and put the house in order, as he has so effectually done in the past. As a matter of fact, redesign engineering has its greatest significance to the older, well established, most efficiently organized and managed industries.

Redesign Engineering, being primarily concerned with cost reduction, is most readily confused with other branches of engineering having this aim. It differs to a marked degree, however, and to make this difference clear, the fields of the related branches of engineering must also be understood. The engineer is a man who solves problems. The moment a problem is solved, it no longer is a problem. The man who repeats the engineer's solution of a problem is doing routine work, while the engineer's work is essentially creative. Needless to say, there are very few engineers. Very many appropriate the title. There are sales engineers, and purchasing engineers, and even the man who installs an accounting system is apt to call himself an engineer, until the word has now become about as much overworked as "lady." We have wash ladies, scrub ladies, and so on, until a woman who can not call herself some kind of a lady is sadly lacking in imagination. When Fredecick Taylor and his little group of associate engineers followed soon by Emerson and his associates, began to piece together the art of Scientific Management, they established Efficiency Engineering. It so happened that one of Taylor's first moves was in Redesign Engineering. The two branches have up to the present been somewhat mixed, or more properly, what redesigning that has been done is largely the work of the

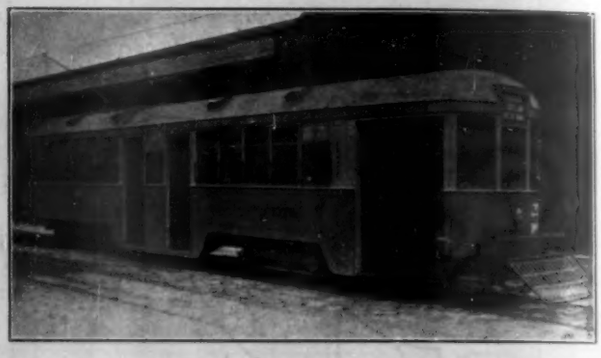


Fig. 9—City Street Car Made of Duralumin By the Cleveland Railway Company. (Electric Traction.)

efficiency engineer. This is no doubt due to the fact that no one has come along to clearly separate the two and start redesigning off on its own merits. The development of Taylor-White self-hardening tool steel was really a problem in redesign. This is the steel now almost universally used for cutting metals, but its inventors' names have been dropped. The new blood introduced into the metal working industries by this high speed steel is a matter of history. Imagine what automobiles would cost if they had to be made with tools fashioned from carbon steel as in the days of our grandfathers. Instead of twenty million cars in the United States there might not be even five million, because, as the selling price goes up, the number of possible purchasers goes down out of all proportion. The present situation as regards number of automobiles in turn affects road building, suburban home sites, moving picture theatres, cash-and-carry stores, and a host of others. Only a few hints of the far-reaching effect on all society are given to show what the new blood, represented by Taylor-White's redesign of the material used for cutting, has done when introduced into the metal working industries.

The true function of the efficiency engineer is the elimination of waste. He shows how to cut across lots instead of going all the way round the block. The redesign engineer points out new and greener pastures, but has nothing to say about which is the shortest route there nor what to do after arrival. The radio is a new means of communication, but merely because it is a means of communication, it is not a telephone or a telegraph. As a matter of fact, the radio has increased the business of these two older forms of communication, and so will the redesign engineer increase the opportunity for the efficiency engineer. Taylor and those efficiency engineers who followed him have taken men, money and materials and shown business how to use them without waste. Really only by accident have they occasionally pointed to new materials and the like as Taylor and White did with their

high speed steel. The world today is literally flooded with the equivalent of "high speed steel." So far as the metal making and working industries are concerned, there is one equivalent which seems to stand out preeminent and that is the fusion welding and cutting processes. It is probably under-ranking them to call them equivalent. These processes have seemingly influenced the growth of the automotive industry already as much as has high speed steel and, now that practically all the special alloys and non-ferrous metals may be welded by both the oxy-acetylene and metallic arc methods, it bids fair to be a still more potent influence. When the fusion processes are as universally adopted as high speed steel, their full influence can be evaluated. Apparently the redesign engineer specializing in the application of fusion welding and cutting is a much needed gentleman among the metal industries today.

Application of Redesign

While this article is concerned only with the general significance of redesign as a branch of engineering, a few specific examples involving fusion welding will help make its application to industry clearer. There are three major classes of saving which result, many minor ones, and an almost endless variation in each class is possible. One of the major classes is represented by a saving in weight either through using less of the same material as heretofore or lighter materials. Another is reducing or eliminating corrosion losses, either atmospheric, chemical, or from exposure to elevated temperatures. The third involves the substitution of less expensive materials. Among the minor classes might be mentioned saving of losses from abrasion by means of surfacing parts subject to wear with metals peculiarly resistant to such action.

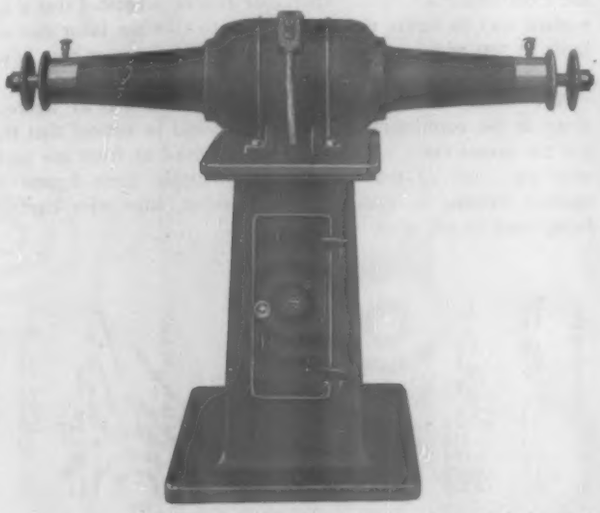


Fig. 10.—Cast Iron Machine Base Redesigned for Arc Welded Standard Section Rolled Steel. (Lincoln.)

As an example in weight saving, a structural steel beam may be used. In Fig. 6 is shown such a beam riveted according to the usual practice. It weighs 798 pounds. When tested by center loading it had an elastic limit of 60,000 pounds and sustained an ultimate load of 74,000 pounds. In Fig. 7 is shown a quite similar arc welded beam, only the overlapping material required for riveting has been eliminated and other advantages, made possible by arc welding, introduced. It weighs 656 pounds or about 18% less than the riveted beam. When similarly tested it had an elastic limit of 65,000 pounds, or 5,000 higher than the riveted beam and carried 4,000 pounds more ultimate load. In Fig. 8 another similar welded beam is shown. More web stiffener plates and a top center plate have been added, bringing the weight up to 795 pounds or approximately that of the riveted beam. This did not result in any increase in elastic limit, but the ultimate load was raised 110,350 pounds. In steel structures, still greater weight savings are possible, because welded girders are treated legitimately as continuous.

The possibilities of saving in dead weight of all conveyances used on land and sea for transport, by employing high strength light metals now available, are enormous. These alloys are relatively expensive, but by taking advantage structurally of the weight reducing possibilities it brings the total cost in many cases, if not all, within practical liits. Aluminum auto bodies are becoming increasingly common, and more recently a street car was built by the Cleveland Railway Company from duralumin. This car is shown in Fig. 9, and weighed but 30,300 lbs., while one made to the same design of steel weighed 43,200 lbs. Taking the light weight into account, the aluminum alloys are in structural form about double the cost of mild steel.

A lecture delivered not long ago before the Petroleum Institute pointed out that this industry suffered an annual loss of two hundred million dollars from corrosion. The petroleum industry has introduced welding into its refinery equipment and pipe lines on a very extensive scale. The resultant economy makes it easy to appreciate why this industry is taking such a lively interest in the use of stainless steel to resist corrosion, in spite of the fact that this metal costs several times as much as mild steel.

Welded stainless steel has been used to stop corrosion losses in the chemical industry. Stainless steel is by no means the only corrosion resisting metal. Nickel, copper, aluminum and others are all valuable, but each more expensive than mild steel, and, consequently, for a broad application they need all the help possible to keep the total cost down. Fusion welding is often the means of making the desirable properties of these various metals available as substantial money savers.

One of the best illustrations of the substitution of cheaper metals is shown in Fig. 10. Here welded mild steel has been used to replace cast iron with, if anything, an improvement in both appearance and strength. Pig iron is the raw material for both metals, but its cost plus foundry and machinists' labor results in this machine base being approximately twice as expensive made from cast iron as when the metal is wrought, practically automatically, in the rolling mill and welding labor only is added.

Conclusions

The preceding examples have been picked more or less at random and described but sketchily. Each one of them would require a book to discuss in detail, and, before many years have passed, probably a library could be filled with descriptions of

the work of redesign engineers. Like all new things, it will encounter the legitimate opposition of the conservative, but there is another sort of opposition that will probably be the most potent factor in holding back from the public the advantages to be derived. Redesign, having its greatest possibilities for introducing new blood among the oldest and best established industries, is going to be obliged to buck the personal pride in methods and product which is always developed to a high plane in such industries. A quite recent experience of the author is a harmless illustration of this. He purchased a household water filter. It was a very fine one, quite possibly the finest made. To his personal knowledge, years had been spent in perfecting it, and, in the language of the salesman, "It was a beauty." The selling price, however, was startling for such an article, being $58.50 cash and more on time. This prompted a few questions which developed the facts that the production cost was $23.00, that it should be $15.00, and would be, if only larger quantities could be sold, but the cost of sales was already so high that there was very little net profit. The contrivance was not very complicated and so the drawings required scarcely ten minutes' study to indicate the possibilities of redesign by substituting other metals, fusion welded. An estimate indicated the weight could be reduced from 30 to 12 pounds, and the production cost from $23 to $6. Cutting this $17.00 saving from the sales price means a reduction of about 30 per cent without changing the spread for sales costs and profit. Using the figures developed earlier in this article to the effect that the number of possible customers is increased from 5% to 10% for every 1% drop in sales price, shows that the volume sold could thus be increased one and a half to three times by dropping the price 30%. A reduction of 30% in the sales price no doubt would reduce sales resistance so that still further price cuts could be made without disturbing the net profit per filter, and, of course, still more customers made available. At just what price the maximum profit would be reached, it is hard to say. The author's statements along these lines brought a smile of ridicule to the filter man's face and provoked the remark, "I guess you don't know much about filters." His guess was correct but so was the reply, "You don't know much about redesign."

What the filter man does remains to be seen. The author is not even mildly curious, for there is plenty of more important work to be done. The little incident, although incomplete, still permits showing the reaction resulting from pride in the product of a well established business. We are reminded of the old saying "Pride goeth before a fall," and the impartial observer will have no difficulty in appreciating that only a miracle will save those industries, which do not give serious consideration to any force so powerful as redesign, from falling under the stress of present day competition.

(NOTE: *This is the first of a series of articles on Redesign Engineering. The second of this series will appear in an early issue.*—EDITOR.)

ESTIMATING COSTS ON WELDING

A complete analysis of a method of estimating the cost of electric arc welding on production work was the main subject of a paper read by Mr. William T. Madden, Industrial Department, General Electric Company, before the April meeting of the American Welding Society, Chicago Section, which was held on April 1st. The speaker made it clear that there are several variables among the factors which go to make up the total cost of welding on any job; in fact it was pointed out that every factor which entered into the total cost would probably be variable. The cost of power for welding may vary from 8/10 of a cent to 3c per kilowat hour. The cost of the electrode material may vary from 6c per pound upwards. The cost of labor may vary from 50c to $1.00 per hour. In his cost analysis, Mr. Madden based his figures upon the work done in one production welding plant where the cost of power was taken as 2c per kilowat hour, the cost of bare wire electrodes at 8c per pound and the cost of labor at 70c per hour. In connection with the labor costs it was also taken into account that the welder would average to work only 70% of the time on welding. In the work under consideration the butt seam and lap seam design predominated. The unit of cost elected was the cost of welding per running foot of seam, and since this cost varies with the thickness of the material, it was worked out for different thickness of material from ⅛ to 1 inch. By means of lantern slides charts were introduced to show the different methods of investigating costs. The first of these charts illustrated how the thickness of the plate determined the amount of weld metal or rather the amount of electrode material which was used to a foot of length. This varied from a tenth of a pound for ⅛ inch thick material to 3.2 pounds for 1 inch thick material. This chart also indicated clearly that the amount of electrode material wasted in stub ends unused decreases with the thickness of the piece welded.

A second chart was introduced to show the power cost per foot of weld for different thicknesses. This ranged from 4/10 of a cent to 24c. The third chart showed the labor cost per running foot, labor being figured in all cases at 70c per hour, This ranged from 3½c to 93c per running foot. When these figures are brought together it is observed that increasing the material from ⅛ inch thickness to 1 inch thickness increases the cost of welding per foot from about 5c to nearly $1.50.

Further study of the figures indicates that the labor charge is the most important item. Therefore it was suggested that a convenient way to figure the total cost is to take the labor cost as a basis at 100 and figure the electrode cost and power cost in percentages of the labor cost.

A summary of the charts with the various sets of figures is given in the accompanying table. It should be noticed that these are the actual costs which have been arrived at from one particular job. All of the work done to supply these figures was manual welding in a down hand position, bare wire electrodes being used in all cases.

TABLE

Thickness of plate	Lbs. wire used per ft. of weld	Cost of wire per ft. of weld	Amperes	Power cost per ft. of weld	KWH per ft. of weld	Ft. per hr. welded	Labor cost per ft. of weld	Total cost per ft. of weld	Wire cost % of Labor cost	Power cost % of Labor cost
⅛"	0.1	$0.008	100	$0.004	.02	20	$0.035	$0.047	23	10
¼"	0.2	0.016	125	0.009	.45	10	0.07	0.095	23	13
½"	0.8	0.064	175	0.05	2.5	2.5	0.28	0.39	23	17
¾"	1.6	0.128	210	0.11	5.5	1.375	0.51	0.748	25	22
1"	3.2	0.256	250	0.24	12.	.75	0.93	1.42	27	26

Following the presentation of this cost analysis Mr. Madden showed some slides of automatic arc welding and commented briefly on the economic advantages of using automatic arc welding on production work. To give an idea on the possibilities of welding on production work he showed several additional slides of different kinds of articles which are now being fabricated in metal working shops using welding to make the joints. In one shop a few articles were made by welding in a rather experimental way. The results were so pleasing that additional jobs were brought to the welding department, and it was not long before this establishment had a department devoted almost exclusively to the fabrication of articles which were to be used in various portions of the plant and which could be made cheaper and better by welding than they could be purchased.

PRODUCTION OF WELDING AND CUTTING GASES IN 1925

In a recent bulletin of the Department of Commerce are some interesting figures on the production of compressed and liquefied gases during the year 1925. Included in this bulletin are statistics regarding several of the gases which are used in oxy-acetylene welding and cutting. In 1925, 69 acetylene producing plants produced acetylene plants to the value of over thirteen and one-half million dollars. 48 hydrogen producing plants at this same period produced hydrogen to the value of nearly $880,000, 141 oxygen producing plants in this period sent out $22,500,000 worth of oxygen.

Heat Treatment by the Oxy-Acetylene Flame*

The Torch Not Only Provides Convenience But Furnishes a Clean, Uniform High Heat, Which Is a Big Advantage in This Work

By E. E. Thum†

ONE of the most valuable trade secrets of the old-time metal worker was the knowledge that most hard metals could be softened by a moderate heating, while red hot steel could be hardened by quenching in water. Many superstitious beliefs were held about the subtle influence of a certain kind of fire used to produce the heat or complex brew in which the metal was cooled. But progress is never based on superstition or prejudice. Therefore one of the greatest accomplishments of the modern science

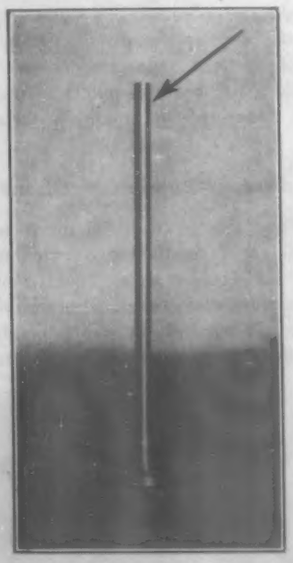


Fig. 1.—Motor Valve Stem Hardened at End.

of metals is the penetration of the fallacies, and the substitution of a body of precise information about chemical composition of alloys and their correct heating temperatures and cooling rates to give desired combinations of strength, toughness and hardness.

The whole trend of modern heat-treatment has been toward uniformity and neutral gas atmospheres within the furnace; toward an accurate control of the temperature by pyrometers (high temperature thermometers); toward standardized routine which insures that each one of thousands will receive exactly the same treatment. Consequently it might appear unorthodox and a step backward to propose the small oxy-acetylene flame for heat-treatment applied by hand, and without pyrometers to measure the effect. Such a supposition is hasty, however, and does not consider the fact that the oxy-acetylene flame is the most precisely and completely controlled of all flames; its temperature, though high, is unvarying; when correctly adjusted the gas atmosphere is neutral or reducing, and therefore without chemical effect on the heated metal; and finally, the action in production is so rapid that the operations proceed with a rhythm and smoothness which is the ideal of production engineering. Therefore the proper application of the oxy-acetylene flame to the local or spot hardening and annealing of many metals closely conforms to the principles of modern metallurgy as outlined above.

*Paper read before the International Acetylene Association at the Congress Hotel, Chicago, Illinois, November, 1926.

†Technical Publicity Department, Linde Air Products Co., New York City.

Acetylene Is Not a Furnace Fuel or a Carbonizing Cement

Having broadly outlined the field of this discussion by the phrase, "local or spot hardening and annealing," it would be well before considering this modern method of heat-treatment, to examine and reasonably discard certain aspects of the subject.

In the first place, heat-treatment by the oxy-acetylene flame does not include the firing of furnaces with acetylene gas. This

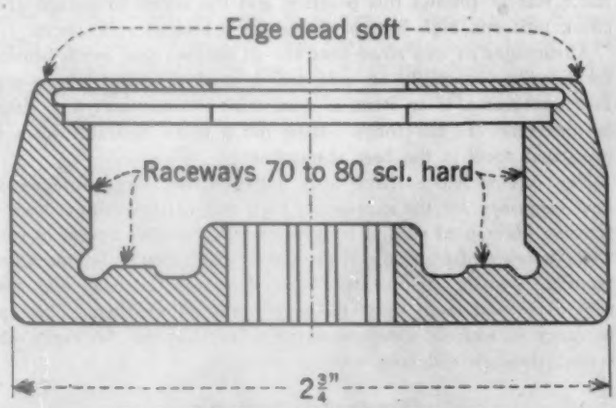


Fig. 2.—Ball Race; Softened at Upper Edge.

has been proposed from time to time, especially when extra-high temperatures have been desired. Seldom, however, would there be a situation where some other gas or oil would not be available at a lower price, which could easily produce the required temperature in a well designed furnace, using forced draft, regenerative heating, or oxygen-enriched blast. The intense oxy-acetylene flame would quickly soften any firebrick lining known at present.

Secondly, heat-treatment by the oxy-acetylene flame does not include case hardening with acetylene gas. Ordinarily, case hardening is done by packing the steel pieces in a granular carbon (called the "cement"), and heating for several hours. Similar results are also produced by exposing the steel to a hot gas; the gas is the "cement" in this practice. Acetylene gas is not

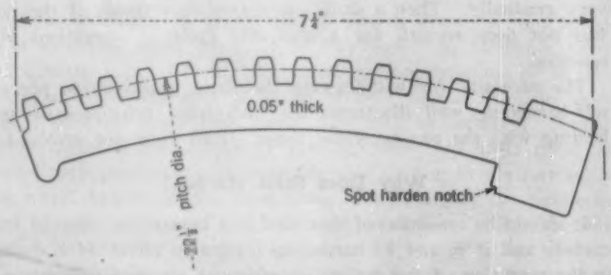


Fig. 3.—Rack for Adding Machine; Hardened at Lower Right Corner.

a desirable carbonizing cement; furthermore, it tends to change its chemical nature spontaneously and with liberation of large quantities of heat when exposed to high temperatures and pressures. For these reasons, the use of acetylene gas for a case hardener would run counter to safety codes. Never preheat acetylene; never compress free acetylene gas above 15 lb. gauge.

Hardening of Small Tools

Perhaps the most obvious use (as well as the most widespread)

of the oxy-acetylene flame for heat-treating is for emergency hardening of small metal cutting tools, like lathe tools, milling cutters and drills. Every machine shop has facilities for hardening tools. But suppose it is necessary to prepare two or three in a hurry. The furnace or forge is cold, and takes time to bring to heat. Instantly the oxy-acetylene flame is at full heat; the cutting edge of the tool may then be brought to temperature gradually by brushing the flame back and forth. (Gradual heating, of course, is necessary to prevent risk of cracking the tool.) At the correct time it is plunged into water. The job is done before the forge fire could be lighted!

On the face of it, such practice is unscientific. It reverts to the "human-eye pyrometer," and the human eye is quite uncertain when judging high temperatures by color. But it should be remembered that enormous numbers of tools are hardened daily with a good degree of success in a blacksmith's forge, and the temperature judged by eye. Hardening with the oxy-acetylene flame merely follows this practice, and the added advantage of a clean, uniform, high heat produced by a neutral atmosphere.

Advantages of this *clean* heat are so obvious that much heating for bending, especially on cold drawn stock or metal where surface appearance is an item, is done with the oxy-acetylene flame in preference to the forge. How much more desirable it is to heat-treat tools in the best atmosphere!

The oxy-acetylene flame also possesses the large reserve of heat necessary for the excessively high temperature required when treating high-speed steel, a temperature unattainable except in very well designed furnaces. High-speed steel should be quenched from a "sweating temperature"—at that heat the edge and corners glaze and seem to at the very verge of melting. This appearance is entirely independent of color, and can be easily observed through ordinary welding goggles.

Emergency Annealing

Other items of emergency work frequently may be done with economy and dispatch. Suppose a hardened screw-cutting tap freezes and breaks short off in the hole. It is easy to draw the temper by heating it to a red heat, when it can be drilled out.

A job utilizing similar principles was done some years ago at one of the navy yards, when it was necessary to make hundreds of holes in battleship armor for attaching paravanes for protection against mines and torpedoes. Armor, of course, is surface hardened to the maximum possible degree. To soften a spot sufficiently for drilling without softening any more metal than was to be drilled out was a nice problem! It was solved as follows: A short firebrick nozzle was cemented to the surface at the correct spot; an oxy-acetylene flame heated the inside surface of the metal to a full red while the outside was doused with a water jet. To prevent re-hardening, the flame was drawn away very gradually. Then a drill was driven to refusal; if the hole was not deep enough for a stud, the cycle of operations was repeated.

The necessity for withdrawing the flame gradually to prevent self-hardening well illustrates the underlying principles of spot heating with the oxy-acetylene flame. Two facts are involved.

Why Does Steel Harden?

It should be remembered that steel is a crystalline alloy of iron carbide and iron, and its hardening occurs by virtue of a change in the condition of the carbon occurring at elevated temperatures ("above the critical temperature," as heat-treaters say). This change consists of a dissolution of the iron carbide crystals into the adjoining iron crystals, much as a band of thugs scatter into a crowded street. On slowly cooling, the iron carbide crystals reform, as the gang re-collects when danger is past. Slowly cooled steels are tough and soft. They are said to be "annealed." However, if quickly cooled, there is no time for the recrystallization of the structure, and the steel is hard and brittle. It is then said to be "hardened." Moderately reheating such hardened steels allows the beginnings of recrystallization; the steel is toughened without loss of much hardness. It is then said to be "tempered."

After these brief definitions, we return to the two facts involved in spot heating with the oxy-acetylene flame. First, the dissolution of the iron carbide crystals into the hot iron crystals occurs at an exceedingly rapid rate. That means that for useful hardening, a spot of metal needs to remain at the correct heat only a matter of seconds. Second, on removal of the flame, the heat, concentrated at a given spot, will be rapidly conducted back into the underlying metal (if it exists in sufficient quantity) often

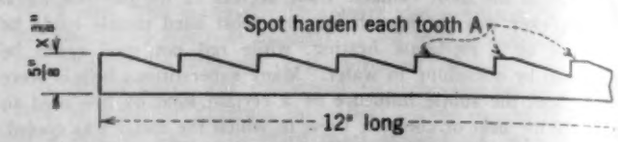


Fig. 4.—Keyway Broach; Hard Teeth, Tough Back.

so rapidly that the spot is said to be "self-quenched" and is thereby hardened.

In other words, any systematic discussion of heat-treatment by the oxy-acetylene flame must consider (a) the variations possible in the rapidity of heating, and (b) the relations between the size of the flame and the mass of metal surrounding the hot spot.

Relationships Between Metal and Flame

Suppose you have a large chunk of metal and a comparatively small flame. The rapid conduction of the heat away from the surface, back into the colder metal, could prevent any spot passing the critical temperature within a reasonable time. No hardening would result. Long heating would merely draw the temper of a piece originally hardened. A large mass of metal and a

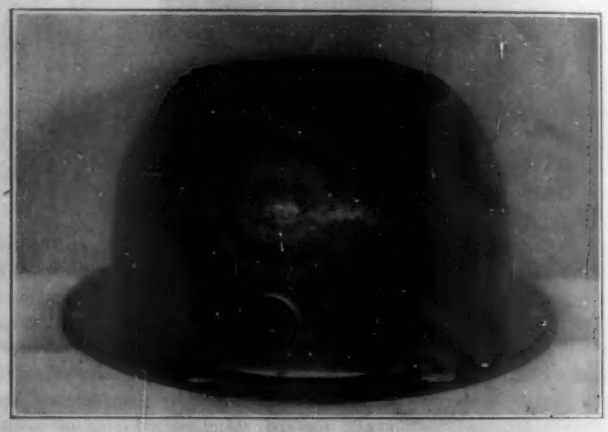


Fig. 5.—Universal Joint Casing. Annealed at Oil Drain.

comparatively small flame would therefore *temper* a hardened steel.

On the other hand, if a larger flame were held steadily on that same large piece of steel, a small spot would rapidly pass the critical temperature. On quenching this in water, high hardness would result. Even withdrawing the flame quickly would give a considerable hardness due to rapid abstraction of heat by the underlying metal. In fact, the only way to prevent a hot spot in a large piece of steel from being hard is to withdraw the flame very gradually, so the temperature at the spot is let down slowly (as was done on the armor plate mentioned above). In general, therefore, to *harden* a spot on steel, one would use a flame of moderate size as compared with the size of the metal part.

In the third place, if a relatively small mass of metal is heated with a moderately large flame, the whole piece becomes heated generally. Water quenching would harden the piece throughout; slow cooling would *anneal* it.

In these pages it will be possible to give only a very few illustrations of these operations in practice, from the dozens available.

Drawing or Tempering

Dies for drop forging, stamping or punching are usually formed of a good-sized piece of fine steel and then carefully hardened. It is frequently desirable to draw the temper of the underside, in order to toughen the block against the working shocks. The hardened die may be partly immersed face down in a little water, and the back brushed steadily with an oxy-acetylene flame until it has been properly tempered. Gradual and uniform heating is evidently necessary to avoid cracking the hard die.

A similar job in production is the manufacture of the ball races shown in Fig. 2. After machining all over, the inner surface and bottom is then hardened to scleroscope 70 to 80. It is necessary then to soften the upper edge, which is done by immersing the lower portion of the piece in a bath and playing the oxy-acetylene flame over the lip.

Hardening

Hardening of a wide variety of pieces is also done with the oxy-acetylene flame—usually on parts which require hardening of a portion of the surface. Take as an instance the little segmental gears used in adding machine (Fig. 3). They are punched from 0.50 per cent carbon steel sheet, 0.05 in. thick. Only the stop at one end needs hardening. It takes about 2 seconds to bring this corner to heat and drop the piece into water.

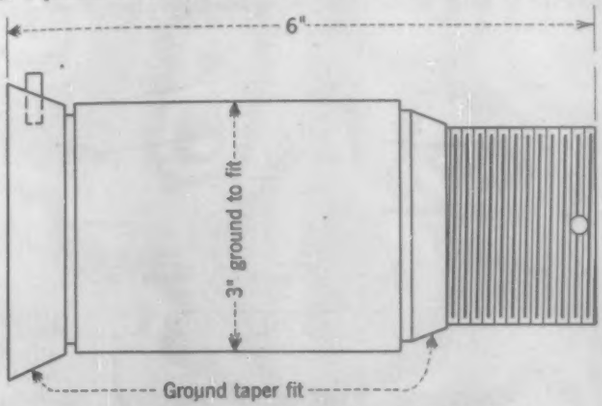


Fig. 6.—Crank Pin; Annealed for Cotter Hole.

Similar hardening in large scale production is done on valve stems for gas engines. As shown in Fig. 1, these consist of a thin round rod rising from the center of a small circular plate. Only the tip end of the rod needs be hardened. Such stems are made of alloy steels (usually having air-hardened properties) of various analyses, depending upon the ideas of the auto manufacturer, but they are heat-treated in the same manner. A hundred or more are arranged regularly in a shallow pan, each one standing on the plate. This pan is then immersed in a circulating bath of water so that only about half an inch of the top of the rod appears. An operator then heats each stem in succession to the correct hardening temperature; the water bath cools the hot rod rapidly enough for correct hardness at the end.

About six minutes is needed for a batch of 100—that means about 3½ seconds each. The workman soon becomes accustomed to the cadence or rhythm of the operation, so he judges the heat as much by the length of time the flame is in contact, as by the color of the heated rod. This is good practice, because of the unvarying temperature of the oxy-acetylene flame.

As a third instance, take the key-way broach sketched in part in Fig. 4. It is cut from a high speed rod, ⅜-in. wide by 12 in. long. The maker had experienced great difficulty in avoiding a slight warping during hardening; therefore he made them only hard enough so they could be straightened after heat-treatment. Unfortunately, however, this hardness did not give satisfactory cutting qualities.

To remedy this troublesome situation, the broach was firmly clamped in a tight fitting slot in a hevy cast iron plate, and the cutting edges *A* were heated with the oxy-acetylene flame, one by one, gradually and uniformly to the sweating temperature, and the hot tooth immediately quenched with an air blast. This gave the maximum degree of cutting hardness to the edges, yet left the back soft and tough, easily capable of being straightened of any slight warping which might occur despite the restraint of the cast block.

Annealing

Fig. 5 shows a universal joint casing, work on which is typical of this subdivision of the subject. It is a spun hemispherical cup made from 3/64-in. sheet. The oil plug hole on the side is made as follows: A 3/16-in. hole is first punched cold, and a small spot then heated dull red. Immediately it is flanged as shown. Two men on this job have a production of 500 per hour. Final operation consist of threading the hole and inserting a⅛-in. pipe plug.

Other metals besides steel harden on cold work to such an extent that further bending or forming will tear or crack the article. Aluminum sheet is of this nature. The oxy-acetylene flame softens spots on cups, so dog-eared lugs can be further made, or spouts turned out. The correct annealing temperature of aluminum is a very low heat—just hot enough so that when a taper of paper is drawn across the spot it leaves a black mark on the metal.

Fig. 7.—Rifle Receiver of Malleable Iron; Spot Hardened.

While annealing in production is usually done on thin metal by a moderate sized flame, it is very useful in softening hard spots on castings. (These are caused by hard ramming or an unexpected chill, and give a lot of trouble to the machine shop which does not know how easily they may be softened. Owing to the more brittle nature of casting, such hard spots must be heated very gradually, and a considerable amount of the surrounding metal heated at the same time. Furthermore, the temperature should not extend beyond a very low red, unless the hot spot is at an edge or corner.)

Similar annealing on portions of heavy forgings is typified by the crank pin shown in Fig. 6. These are used for link and valve motions on steam engines. After the forging has been machined it is hardened all over, and then certain portions ground to exact size. If, after the assembly, the cotter pin hole is not exactly right to fit into the castle nut, the end of the pin is annealed by an oxy-acetylene flame, and a new hole may then be drilled.

Work of this sort is sporadic, but nevertheless of enormous convenience to the machinist or erector, who is often beset by difficult problems. A more common application to quantity production is in case-hardening practice.

Very often it is desirable to case harden only part of the surface. For instance, cam-roller pins must be very hard in the body to resist wear and the ends soft enough to be riveted into a tappet. Partial case-hardening of this nature is common, but is not very easy. In the past it has been the practice to cover the places to be soft by an impervious substance or by copper plating, then pack the parts in carbonaceous materials and heat in the usual way. Often, however, the protection was not complete; the regions desired soft have an exasperating way of coming out hard! After softening these spots, almost without number, by the oxy-acetylene flame, the metallurgist had an inspiration. "Why bother with the coating? I'll just harden them all over and soften the parts I want soft with the flame."

Hardening of Malleable Iron

Spot hardening of malleable iron is one of the most recent metallurgical developments which undoubtedly will have great influence on machine production in the near future. An indication of its possibilities may be seen in the receiver for a sporting rifle, shown in Fig. 7.

This piece is machined to close limits all over—machinability is an essential. It must be tough to resist the shock of exploding powder. It must be hard in at least six regions, to resist wear of moving contacts. It must not warp out of line in the least during the heat-treatment. All these conditions are not easily met.

Three manufacturing methods have been used extensively for such work. The receiver may start as a forging, relatively soft; after machining it is case hardened in a cyanide bath. The principal objection of this plan is that the hardened surface produced by cyanide is very thin and extremely brittle.

Or the receiver may be cut from a block of higher carbon machine steel, and then hardened at the necessary spots, or might be hardened all over. But such steel is much more difficult and costly to machine than a forging of softer steel, and is quite liable to warp slightly on quenching.

Finally (and preferably), the receivers may be made of high grade malleable castings. A malleable casting is the ideal material to machine; it is less expensive than either a forging or machine steel; in body it is tough and strong; finally, under the oxy-acetylene flame it may be spot hardened easily, raising its scleroscope number from the original 15 to an ultimate 50.

Malleable iron is seldom regarded as a metal susceptible of hardening. It resembles wrought iron in its softness and toughness. Furthermore, it is essentially different from steel, since it is an alloy of iron and free carbon. However, it is found that under the quick sharp heat of the oxy-acetylene flame, the particles of free carbon dissolve readily in the iron crystals, and a satisfactory hardening results from a quick quench. However, it is necessary that the heating be intense and very brief. Herein lies the advantage of the oxy-acetylene flame.

As an instance of the speed with which this work is done, the receiver shown in Fig. 7 was hardened with flame from a medium sized tip. A ⅛-in. slot in ¼-in. metal requires only 2 seconds to bring to a quenching heat; at another place a ⅜-in. groove on ⅞-in. metal requires 8 seconds.

By virtue of low-cost production, tough body, and satisfactory spot hardening qualities, malleable castings heat-treated with the oxy-acetylene flame evidently hold out great economies in machine production.

WELDS OLD BELL

The welder's art has brought to life at Taunton, Mass., an old 900-pound bell which was cracked some 40 years ago, and which remained silent from that time until February 12 of this year. The work of repairing, which was done with the bell in place, was under the direction of the General Electric Co. The crack, 17 inches long and varying in section from 1 inch to 2⅝ inches, was chipped out, cleaned and repaired for welding. The bell was first pre-heated and then a welding operator with a carbon arc type welder started building up the crack. He finished the work with the metallic arc process. The bell was cast in 1808 by George Holbrook, an apprentice of Paul Revere.—*Foundry.*

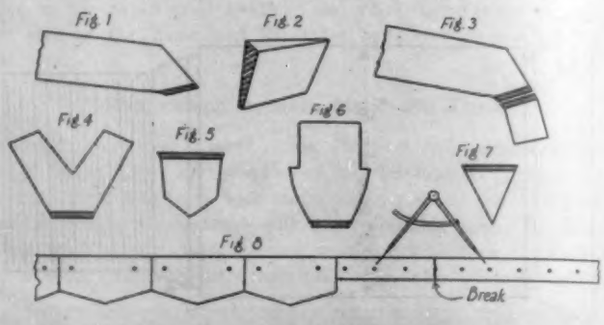
WELDING HELPS THE FARMER

By L. S. Huling

It might be interesting to blacksmiths and welders in the farming districts, who have welding plants in their shops, to know how we use our plant in welding points on ploughshares, cultivator shovels, lister shares and subsoilers, also in welding sickles of headers, binders and mowers.

For ploughshares we trim the point as in Fig. 1, cutting from the top so as to form a bevel, then take a piece of steel about one-inch square by two inches, or that equivalent, and draw out to something like a wedge shape (Fig. 2) so the heavy part will match the bar side of the share and the other the cutting edge.

The thin or cutting edge should be about the same thickness as a dull share, so as to weld easy. Then, placing the share and point in position for welding, set the point at a little angle (Fig 3) so when drawn under the hammer it will take its regular position. We bring the parts to be welded up to a good heat, which starts the welding off in good shape, starting with the thin edge first. We direct the flame towards the heavier part, thus making it less difficult to weld the thin edge, using one-eighth inch Norway iron for filler and weld from top only.



After welding we let it cool until the red is gone, then reheat to about 1500 degrees F., let cool down again until the red is gone, then it is ready to be drawn out and finished and is just as good as new. Lister shares are pointed in the same way, only we use a piece of steel cut from an old ploughshare. Fig. 4 and 5 show share and point ready for weld.

Cultivator shovels are prepared in the same way (Fig. 6 and 7), the heat-treatment being the same as for ploughshares.

Old buggy axles make good points for ploughshares and old ploughshares make good points for lister shares and cultivator shovels.

The heat treatment takes care of the soft filling material besides normalizing the welded parts.

Last but not least are sickle bars. There is a great strain on the bar next to the head, and a good weld is absolutely necessary, especially on headers and binders. Where a man has a crew of men in the field, a broken sickle means everything is held up, so it's up to the welder to get the work out as soon as possible, and still do a first-class job of welding. Of course, the breaking of sickles is due to worn heads, wrist-pins and roller bearings. If parts are in good shape a sickle will seldom break, so we always suggest to the owner to see that these parts are in good shape or another breakdown is sure to come. What the welder has to do is make his weld so strong that it will break somewhere else before breaking in the weld. We remove the head and a few sections from the bar then place the broken parts in proper position and by using a center punch and dividers (Fig. 8) we keep an accurate measure, so there is no time lost in fitting after welding. Then we bevel the parts for welding and allow a very small fraction for contraction, and using one-eighth inch Norway iron filler, fill the V flush and run along both edges. If the break runs through a rivet hole, fill the hole and redrill. After the weld cools down, reheat in the same manner as for plow points, etc. If bar needs straightening, do not straighten until after heat treatment. Grind off the surplus metal, replace sections and head and the job is done.

Perfecting a Product by Welding

A Specialized Development of Flash Welding Has Made it Possible to Produce a One-Piece Steel Door in the Weisteel Factory

WHEN a welding process makes it possible to turn out a product which is exactly what the manufacturer wants it to be and which could not be produced by any other manufacturing process, the user is naturally a strong advocate of welding. A product which fits into such a classification is the line of Weisteel compartments made by the Henry Weis Manufacturing Co., Inc., at Elkhart, Indiana. This firm was formerly located in Atchison, Kansas, and moved to a new modern factory at Elkhart

Fig. 1.—Weisteel Hospital Installation.

in May, 1926. The compartments made in the factory are for toilets, showers, dressing rooms, storage rooms, hospital cubicles, waiting rooms, janitors' closets, utility corridors, cabinets, etc. All of these products are made from sheet steel varying from 22 to 10 gauge. The individual parts of the different units in the line are cut and formed from steel sheets in the factory and the fabrication processes, in so far as the joints are concerned, are based on welding.

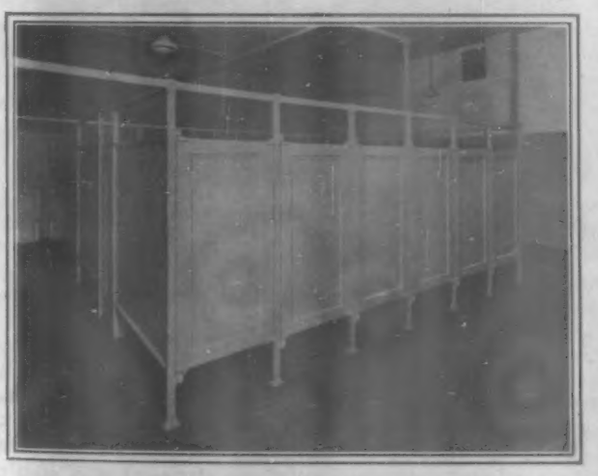


Fig. 2.—Weisteel Compartments in a Public School.

The method of construction furnishes a line of compartments that are sanitary and substantial and also carry a quality of finish which makes them harmonize in the most exacting surroundings. Figure 1 shows a typical installation of compartments in a hospital, and Figure 2 shows an installation in a public school building.

In the fabrication of the all-steel doors used in the above installation there has been developed an unusual application of electric resistance welding which closely approaches the solution of an impossible problem.

Figure 3 shows a section through the door and Figure 4 is a phantom view of one door showing how a small channel reinforcement is used to give extra strength at the corners. The door stiles and rails are formed of 18 gauge, full pickled, cold rolled, copper bearing steel, and the panels of 18 gauge steel of the same quality. As Figure 4 indicates, the stiles and rails are mitered,

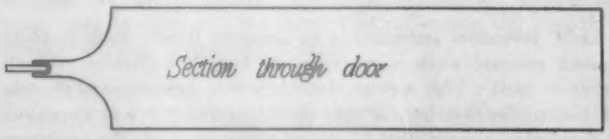


Fig. 3.—Section Through Door.

and then welded together at the corners. The reinforcing channels are welded together in the same operation.

Bearing in mind the lightness of the metal and its tendency to warp when heated, and also the somewhat complicated shape of the parts at the line of welding, it is immediately apparent that some unusual process would have to be followed in order to secure a finished door which would be entirely free from any sign of distortion. These doors when finished show no sign whatever of a joint. The entire casing is one piece.

Fig. 4.—Phantom View of Door Corner.

The fact that it was possible to develop a welding method for the assembly of these doors, is a tribute to the skill and resourcefulness of the engineers in the Henry Weis plant. This is a case where the men interested in production have made a thoroughly searching study of the different welding processes, and by becom-

ing acquainted with them have been able to get the maximum value and satisfaction from welding. The process used is commonly called flash welding. The work is done on the Federal Type No. 60 butt welder shown in Figure 5. The assembly program for a single door is to make two of the end welds first, then slide a panel into the casing thus formed, and finally weld on the second rail section, one corner at a time.

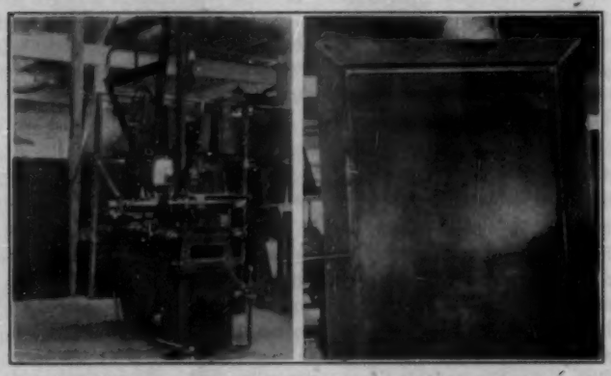


Fig. 5.—Butt Welder Used for Welding Door Corner.
Fig. 6.—Corner Welds Before Grinding.

Early difficulties encountered in attempts to use flash welding in such unusual work were traced to losses of current through the work itself. This was an obstacle which threatened to prevent the use of the machine for this particular job. It was overcome by developing a method of insulating the work while the operation was going on. The company has been granted patents for the development of this process. Those who have seen it demonstrated are impressed with the high rate of production secured, and also with the advantages which it confers upon the finished product.

The small ragged burr which is flashed off is easily removed. The doors after being welded go directly to the finishing department shown in Figure 7 where the whole door is prepared for painting and enameling.

Fig. 7.—The Finishing Department Removes All Traces of Welding.

Although the operation described above is probably the most interesting part of the welding program in this factory on account of its unique features, it is only one of a number of uses which are made of welding. The net result is a rigid steel product which appeals to the consumer through its fine appearance and its promise of maximum utility.

Sanitation is assured by a design which closes all joints and prevents the accumulation of dust and dirt. Panels and posts of the partitions are interlocked and gas welded at top and bottom. The bottom of the front post is firmly held into the floor shoe. The top is rigidly anchored to the head rail. Each partition is a single substantial unit. There are no unsightly edges or open seams. Joints between panels and rails, panels and posts are closed and sealed. When installed there are no parts to wear out, but with average care installations of this type of equipment should last as long as the building in which they are used.

Figure 8 is a phantom view of the connection of a partition panel to a front post. It is reproduced here to show how the partition rails are locked into the post and then securely welded in place. The welding operation used here is the oxy-acetylene method and special jigs are used to hold the parts rigidly in place while the welding is being done.

It is to be expected that in a plant where such a variety of

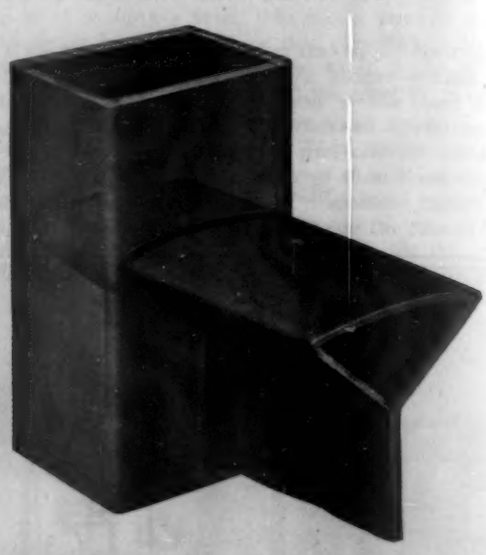


Fig. 8.—This Panel to Post Connection Is Gas Welded.

sheet metal products is manufactured that a considerable use would be found for spot welding. In the Weis plant the spot welding equipment consists of a No. 444B Federal spot welder, a No. 112 Junior Federal spot welder and a No. 124 Junior Federal spot welder.

Figure 9 shows the first mentioned spot welder in operation.

Fig. 9.—The Spot Welder Has a Wide Range of Uses.

Here the operator is spot welding a small plate to a special form. It will be noticed that there are several different shapes and sizes of electrodes available for use with this machine. The possibility of using different electrodes for different classes of work greatly increases the range of work which can be performed on an individual machine of this type.

Figure 10 shows four different arrangements of spot welding electrodes. In one factory satisfactory spot welds were obtained by using the arrangement shown at A in Figure 10, with an in-

crease in production and a considerable saving in electrode cost as compared to the arrangement shown in B, Figure 10. The arrangement C is used for close work in corners and D is an arrangement which uses a metal button between the electrodes and the work.

The range of work for the oxy-acetylene torch is equally impressive when one starts to make a thorough study of sheet metal

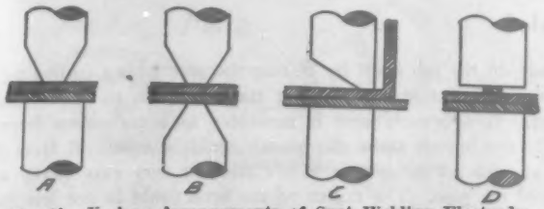


Fig. 10.—Various Arrangements of Spot Welding Electrodes.

fabrication. Half a dozen gas welders are constantly at work in this plant, some of them on regular production jobs and others on the great variety of special jobs which can be so quickly and conveniently handled by a clever welder.

Because of the large number of short seams to be welded there is installed at each welding station a device for saving oxygen and acetylene with the torch while not in operation. The torch when not in use is hung upon a hook which shuts off the welding gases and releases them at the desired pressure when the torch is picked up.

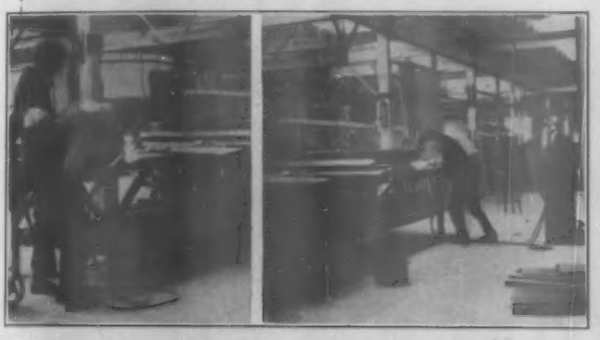


Fig. 11.—Special Jobs Keep Two Gas Welders Busy.

The kind of satisfaction with welding which leads the user to make special mention of it in selling his product is found everywhere in the Henry Weis plant. Back of this satisfaction is a thorough knowledge of the different processes and their possibilities. The management is kept well enough informed to be able to get the best kind of operation and to use each method where it will do the most good. The result is a welded product in which they can point out marked points of superiority over competitive lines.

SWOPE PREDICTS WELDED BUILDINGS

A large building, using electric welding as a method of construction instead of the usual riveting, is planned by the General Electric Company according to Gerard Swope, its president. Speaking before the New York Building Congress April 6, Mr. Swope's subject was "Electric Power in the Construction of Buildings" and, in substance, was as follows:

"It is difficult to picture the changes that have come about in large building operations by the greater use of electric power. Not so many years ago brick and mortar were taken to the different floors on the backs of human beings, and now the picturesque hod-carrier has disappeared and his place has been taken by electric motors.

"Electric power, as a matter of fact, has been one of the important factors that have made possible the construction and erection of these tall buildings, as well indeed as their operation, and the work that is done by electric motors in erection is almost inconceivable. An appreciation of it however can be had when the statement is made that in the erection of one of the large buildings in New York, the total hoisting work was 64,000,000 foot-tons, which means raising 64,000,000 tons a foot, or means raising 640,000 tons a hundred feet.

"In their daily operation, tall buildings would be impossible if it were not for electric motors used in connection with the elevators, which have been developed for such sure and rapid service.

"In the building industry, as well as in industry in general, where earnings of labor have risen so rapidly, the use of electric power has been an important factor in keeping costs down to such a point as will make a fair return on the investment in these buildings possible.

"One of the latest developments of the electrical industry, in connection with the erection of buildings, is electric welding of steel structures. This still is in the developmental stage, but some buildings have already been erected using electric welding and others are projected. The advantages are a reduction in steel sizes because provision in strength does not have to take into consideration holes for rivets, reduction in cost of handling because engineering layouts showing detail of rivets will be unnecessary and structural steel can be shipped directly from the mill to the structure that is to be erected and a further reduction in cost of assembly, and in addition an advantage of inestimable value in the almost total elimination of noise which is now attendant in the riveting of steel structures. The General Electric Company has plans for the erection of a large building, using the method of electric welding instead of riveting."

MANUFACTURERS RESERVE SPACE FOR DETROIT SHOW

If the early activity in reserving space is any indication of what the success of the fall meeting of The American Welding Society, with its exposition of equipment in conjunction with the National Steel and Steam Tool Exposition, will be, the industry can expect to make the most impressive showing that it has ever enjoyed. W. H. Eisenman, Secretary of the American Society for Steel Treating, 4600 Prospect Avenue, Cleveland, Ohio, who is in charge of the space reservations, reports that the following concerns have already made reservations for exhibit space, although it is only a few weeks into the first announcement for the complete arrangements for the exposition was made:

Acme Electric Welder Co.
Air Reduction Sales Co.
American Brass Co.
American Electric Fusion Corp.
Carbic Manufacturing Co.
Chicago Steel & Wire Co.
General Electric Co.
Gibb Welding Machines Co.
Linde Air Products Co.
Metal and Thermit Corp.
Northwestern Manufacturing Co.
Page Steel & Wire Co.
John A. Roebling's Sons Co.
Shawinigan Products Corp.
Thompson Electric Welding Co.
Una Welding and Bonding Co.
Wall Brothers Co.
Westinghouse Electric & Mfg. Co.
Wickwire-Spencer Steel Co.

A glance through this list will show that there will be plenty of variety in the exhibit because practically every branch of the welding industry and every welding process is included in the list. Every effort is being made to secure 100% representation for the industry in this exhibit at Detroit. It is a splendid opportunity for the welding industry to make a desirable impression upon industrial executives from all over the country. These men will be particularly attracted to the welding process if the exhibits are so arranged as to display welded products in a way which will show the applications of the different processes.

Welding in Plumbing and Heating*

Experimental Installation Shows Advantages of Welding Torch in Assembling Low Pressure Heating Systems

By S. E. Dibble†

WHEN wrought iron pipe was first manufactured, it was necessary to find some satisfactory method of connecting the ends to form a continuous line, and some means of breaking into the line for branches. After considerable time had been spent, the threaded joint was finally developed and adopted, so now the screwed fitting, coupling, flanges, etc., are used universally wherever wrought iron and steel pipe is used. These threads were developed into what is known as the Briggs Standard, so that fittings and pipe threads would be universal throughout the parts of the world where pipe is used.

For high pressure work, it is necessary to use heavy flanges with some soft metal between the flanges, or when two flanges are drawn together by bolts it is sometimes necessary to peen the ends of the pipe on to the flanges by expanding with rollers so that the connection will be tight. It has recently been developed that in high pressure work most connections are welded. Throughout high pressure work welded joints have become quite a factor, and welding is being done to a great extent. On long gas and oil lines the welding process is being used almost exclusively, and occasionally the welding process is being used on low pressure work, such as hot water and steam heating for buildings. It is particularly advantageous to use the welding process in making up the headers in steam boilers in such work.

Welding Torch Perfect Tool for Low Pressure Lines

There is no reason why the welding torch could not be used in assembling the entire low pressure heating job. The welding torch and its entire equipment has been so simplified that it can be used in most any position, and the welding process has been so developed that by the proper use of welding rods, flux, and method of handling the torch perfect welds for low pressure work can be made with very little difficulty. This makes it all the more reasonable to believe that welding joints instead of threading joints for heating systems will in time become almost universal.

For the sake of comparisons, consider the necessary material to take on a job for a hot water heating system, using piping and fittings. There will be a variety of fittings, elbows and tees, both straight and reducing, unions, flanges, stock and dies, reamers, wrenches, vise, oil, and pipe cement. When the fittings were listed, it will be noted that to get the proper reducing fitting in the proper place, the entire job had to be gone over almost in detail. In practically every case where fittings are used, we are confined to the ninety degree off-take from a branch connection, and where a ninety degree bend is considered, we are confined to the elbow of ninety degrees or two forty-five degree fittings.

The necessary materials and tools to carry on the above mentioned job if the joints were welded are piping and the welding and cutting outfit. However, greater skill would be necessary to assemble the welded job. The personal factor is far greater in the welded joint than in the threaded joint.

Flow of Water

Consider the flow of water through a hot water heating system. In addition to the friction caused by the side walls of the pipe, allowance must be made for the added friction caused by fittings, the ends of pipe extending into the fittings, unreamed pipe, and the abrupt bends. On a welded job the change in directions would be made on the job itself by cutting the pipe with a cutting torch at the proper angle and welding the branch in to fit the angle desired. If a branch joint is necessary as a connection from a main to the branch main, the branch could be taken off from the main at such an angle that would allow a very easy sweep and grade of the pipe. The radius of the bend could be not less than five times the diameter of the pipe, thus practically eliminating any friction in the bend itself. There would be no ends of pipe sticking into the fitting to cause additional friction, and the roughness of the joint would be absorbed by the welding process. It is my belief that a job installed, using the welding joints, would have less frictional resistance than one installed with fittings. We all know that the hot water heating job is dependent upon the easy flow of water, that the differential pressure of the flow and the return is very slight, and that forty-five degree ells are constantly being used to reduce the friction caused by a ninety-degree ell. Therefore, it seems to me by eliminating these fittings and bending the pipe by heating and making welded joints which are smooth, the resistance offered against circulation would be removed, and the flow of water from the boiler to the radiators would be greatly improved.

Welded Heating Plant Made in Carnegie Institute Laboratory.

Welding Costs Less

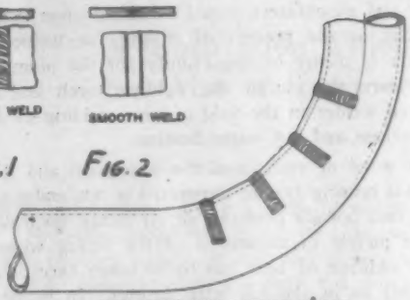
The cost of the welded joint is very hard to determine at this time. A two-inch joint has been estimated to cost fourteen cents;

**Paper read before the Third Annual Three Day Institute of the Department of Plumbing and Heating, Carnegie Institute of Technology, Pittsburgh, Pa., January, 1927.*

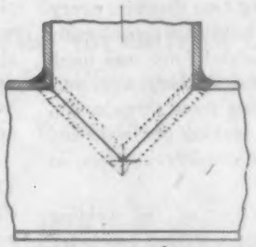
†Professor, Plumbing, Heating and Ventilating, Carnegie Institute of Technology.

FIG. 1

FIG. 2



LONG SWEEP RIPPLE WELDED 90° BEND



SECTION SHOWING 90° WELDED JOINT

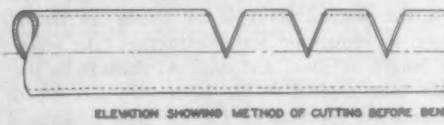
FIG. 7

VIEW OF 90° WELDED JOINT

½ TEMPLET FOR CUTTING END OF PIPE

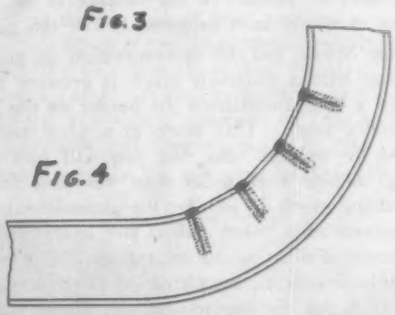
½ TEMPLET FOR CUTTING HOLE IN PIPE

FIG. 8



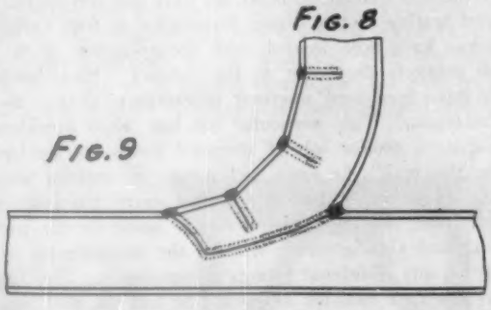
ELEVATION SHOWING METHOD OF CUTTING BEFORE BENDING

FIG. 3



SECTION OF LONG SWEEP 90° BEND RIPPLE WELDED

FIG. 4

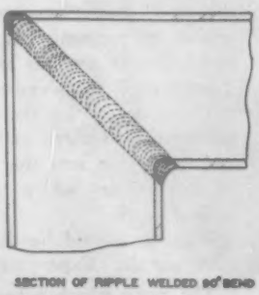


SECTION OF RIPPLE WELDED T JOINT

FIG. 9

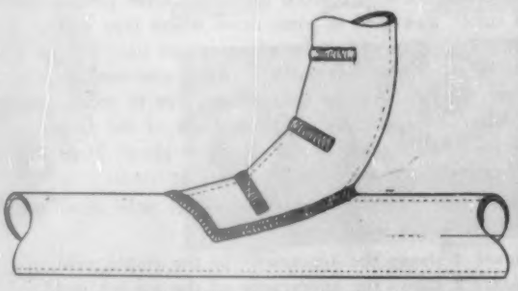
RIPPLE WELDED 90° BEND

FIG. 5



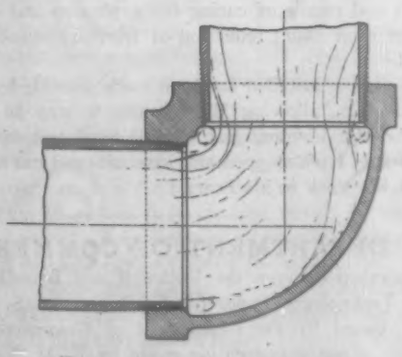
SECTION OF RIPPLE WELDED 90° BEND

FIG. 6



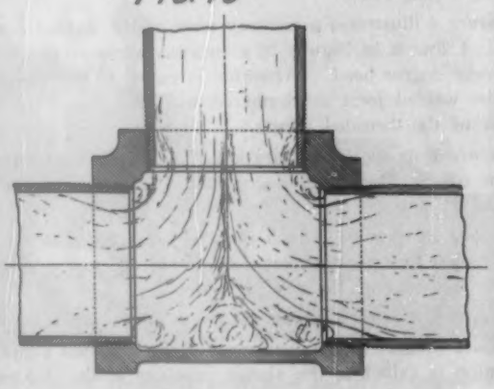
RIPPLE WELDED T JOINT

FIG. 10



TYPICAL CROSS SECTION OF PIPE JOINT

FIG. 12



TYPICAL CROSS SECTION OF PIPE JOINT

FIG. 11

a two-inch cast iron elbow is fourteen cents. The cost of a cast iron tee is twenty-one cents. Therefore, an elbow itself would cost as much as the welded joint completed would cost. If we add to the cost of the elbow the labor of cutting two threads, every ninety degree bend where fittings are used would cost considerably more than a ninety degree bend where a welded joint was used. The same thing is true of the tee. If a tee costs twenty-one cents, and added to this the cost of labor in making three threads, and compare it with the fourteen-cent charge of making one weld and branch, we can readily see that the cost is considerably less, in favor of the welding process.

While these figures on paper show in favor of the welding process, it would not be any cheaper to install a welded job today for the reason that the way of getting at the work, the method of preparing joints is not sufficiently known so that speed could be obtained in erecting a job. It is, I believe, in the interest of the owner, the contractor, the steamfitter, and the plumber to increase the efficiency of the work that they install to the fullest extent, and by a little study in the reducing of friction in hot water heating system, the welded process, for making joints will far outweigh the process of the threaded joints.

The Sample Installation

Having this thought in mind, we have had erected in the plumbing and heating shop a sample installation of four radiators where all joints have been welded, with the exception of the one joint which connects the boiler to the radiator. Easy bends of long sweep have been used wherever necessary to change the direction of the piping. This particular job has taken considerable more time than a similar job of threaded joints, as we have had to "blaze the trail", in ways and means of making these welded joints. However, it has shown that every tee joint and every branch joint, and every elbow can be made on the job with the welding and cutting torch, without the necessity of bringing on to the job any additional fittings or equipment. This job was laid out as any four radiator job would be laid out, that is, the welder was given a rough sketch of the installation, and he proceeded to install the work from that sketch just the same as the plumber or steamfitter would proceed under the same circumstances. The pipe cutter was used in some cases where pipe was to be cut off from a length so as to take advantage of the "V" cut which was made by the cutter. When this cutter was used, it was unnecessary to file the bevel on ends of the pipe to receive the weld, as the cutter automatically did this. Most of the joints on this job were made at the bench, and a few in place. Holes in the main for branch joints were cut with cutting torch.

There are a few illustrations which will show the ways in which the joints were made.

Figure 1 shows the appearance of the ripple weld.

Figure 2 shows the appearance of the smooth weld.

Figure 3 illustrates the preparation of a ninety degree bend, having a long sweep.

Figure 4 illustrates a cutaway view of the welded ninety degree bend; below it in Figure 12 a cutaway view of the fitting, using a ninety degree bend. (Attention is called to the smooth interior of the welded joint as compared with the extremely rugged interior of the threaded joint.)

Figure 7 shows the preparation of a T-joint where the branch is taken off at the ninety degree angle in similar fashion to the threaded joint.

Figure 10 shows a branch joint which is taken off at the angle, eliminating to a great extent the friction due to the abrupt change in the direction of the flow of water.

Figure 9 illustrates a cutaway view of the welded joint.

Figure 11 shows a cutaway view of the threaded T-joint. (Again attention is called to the abrupt passages in the T-joint and the corresponding smoothness of the welded joint.)

All of this work was done by the welder and not by a plumber or steamfitter. This thought prompted this particular lecture as at the present time a great many of these jobs are being installed in the different parts of the country and they are not being installed by the plumber and steamfitter. If we could think of such a condition arising whereby a sudden demand was made upon the industry to have all joints welded, we would find that very few plumbers and steamfitters would be called upon to do the heating work. But as the process of calling for welded jobs will be slow, there is plenty of opportunity for the plumber and steamfitter to learn the use of the welding torch and to become an experienced welder in the field of pipe welding as applied to low pressure steam and hot water heating.

Now a word or two about the expansion and the contraction. The welded heating system illustrated is not under pressure. With steam at two pounds pressure on all joints, no leaks were showing. The matter of expansion of the piping when under stress from the addition of heat has to be taken care of in the welded job as well as in the job with fittings. In fittings, it is taken care of by swing joints and loops, and if not taken care of in this manner, the result will be cracked fittings. With the welded process, the welded joint is as strong as the pipe itself and, therefore, as expansion and contraction take place it is absorbed by the length of pipe, and does no damage to the joint. Steam heat has been applied to the laboratory job five or six times so there has been opportunity for the pipe to expand and contract that number of times. If any damage to the joint or pipe was to occur, it would have happened before this time.

I bring before you this demonstration on pipe welding to confront you with a condition which is growing rapidly. To illustrate, on a large installation the header on the boiler is naturally pipe fitter's work. This work in a great many cases is being installed by welders. So that you will find considerable more welding on pipe work today than was done five years ago. All this welding work is lost by the steamfitter. Welding headers being successful, it is but a short step to weld mains and branches, thus almost eliminating the steamfitter. You know this condition and you have seen the completed job in the Plumbing and Heating Shop. Is it not the business of the plumber and steamfitter to learn how to weld? I believe they should, and at once. Welding has another point which I wish to bring out. The personal factor, that good, honest workmanship enters into the making of a weld almost 100 per cent. Any person can with the welding torch melt metal, but it requires great skill to make a strong tight weld. Therefore, if the plumber and steamfitter would take the welding torch as one of his tools he would be adding to his industry an item which required skill to perform. The introduction of iron and steel pipe into the plumbing industry took away that part of the industry which required the highest degree of skill, that is, lead work.

Welding should be done by mechanics of the various trades using metals. Expert welders would soon be developed.

The work which I have shown you is not ideal nor complete, the idea, however, is. Before you as a group undertake to install this kind of work, a number of details must be worked out, that is, ways and means of caring for expansion and contraction; patterns for each joint; reduction of friction; smoothness of interior of weld.

The job now installed has been made possible by the Air Reduction Sales Co., allowing Mr. Canning to stay on the job to complete it. Mr. Canning has worked hard and overcome obstacles which would have stopped any man who did not have the development of his work in his heart.

NEW DEPARTMENT OF COMMERCE PAPER

Relationship between the Rockwell and Brinell numbers is the title of Technologic Paper of the Bureau of Standards No. 334 recently issued by the Department of Commerce. The book is the result of an investigation made by F. M. Tatrenko. Copies may be obtained by writing to the Superintendent of Documents, Government Printing Office, Washington, D. C. The price is fifteen cents per copy. The equations developed in this experiment may be used to determine within an error of plus or minus 10% the Brinell hardness number when the Rockwell hardness is known.

Replacing Castings With Welded Steel*

A Substitution Which Results Not Only in Lower Costs but Also an Improvement in Physical Characteristics

By W. L. Warner†

IN MACHINE construction, cast iron finds its widest field of application. No other metal which can be cast in complex forms can be produced with such ease and at so low a cost. Cast iron has several competitors in this field, the principal ones being malleable cast iron, cast steel, and the cast brasses, bronzes, etc. Each of these materials possesses properties not possessed by cast iron, such as greater strength, toughness, or non-corrodibility. They are also more expensive. However, in the past when the conditions of service have been such that cast iron could meet them, it has had no competition, but the advent and development of fusion welding has given a new aspect to this situation.

The development of improved welding methods during the last ten years has placed at the disposal of steel and iron workers a process of joining metals which is rapidly revolutionizing industrial production methods. Welding is truly a steel founding process applied locally on a small scale. It renders possible the joining of metals in a satisfactory way with a minimum of time and labor expended in the preparation and completion of the job.

By substituting rolled material for cast material, industry is following somewhat along the lines of past experience, namely, the substitution of rolled steel shapes for iron and steel forgings and castings because of lower cost and improvement in physical characteristics.

The rolled section is originally a casting, but an inexpensive one because ordinary foundry methods, including patterns, are not employed. This saving practically offsets the cost of the subsequent mechanical working to reduce it to its final shape, during which process its grain structure is refined and its physical properties improved. Its use in machine design permits the application of manufacturing methods which often reduce the cost to half that of a machined casting of the same weight. Furthermore, the use of a rolled section instead of a cast section is always desirable wherever possible, due to a reduction of the amount of metal required for the same strength and stiffness.

There is less waste involved in the fabrication with rolled material than with castings and the number of machining operations is less. It is possible to fabricate almost exactly to size, while a certain allowance must be provided for in a casting due to shrinkage, roughness, and physical variations in the moulding operation.

The elimination of the pattern shop and pattern storage is another feature which is allowed by fabrication of rolled material. This item reduces overhead—the great problem of the factory cost department.

It goes without saying that the use of welding for fabrication with rolled shapes makes this development more attractive to the designer and fabricator because of the flexibility of the process. Rivets could be used undoubtedly, but when one considers that it is necessary to work on both sides of a joint to rivet, and requires from two to four men, while welding necessitates one man working from only one side with the resulting elimination of secondary connecting shapes, the process of fabrication by welding becomes more attractive than ever. If changes are necessary during construction how easy it is to cut out and fit in pieces to make the change, while with a casting, a new mould is usually required.

Fig. 1.—Gear Blank of Rolled Steel Plate Welded Together.

Fig. 2.—Completed Steel Gear After Completing from Welded Blank Shown in Fig. 1.

Fig. 3.—Arc Welded Bulldozer Die.

Fig. 4.—Arc Welded Structural Steel Base for Motor-Generator Set.

*Abstract of a paper by the author, delivered Jan. 4, 1927, in New York, before a joint meeting of the Metropolitan Sections of the A.S.M.E. and A.W.S.

†Industrial Engineering Department, General Electric Co., Schenectady, N. Y.

There is also the possible chance of using automatic welding machines for this work and this procedure always makes for reduced costs as is evidenced by the general trend of industrial processes at the present time. The welding machine will perform continuously without tiring, while the manual welder requires a certain amount of relaxation and relief from holding the arc over long periods. Also the problem of labor turnover becomes less acute where the main dependence is placed on machines for performing routine jobs.

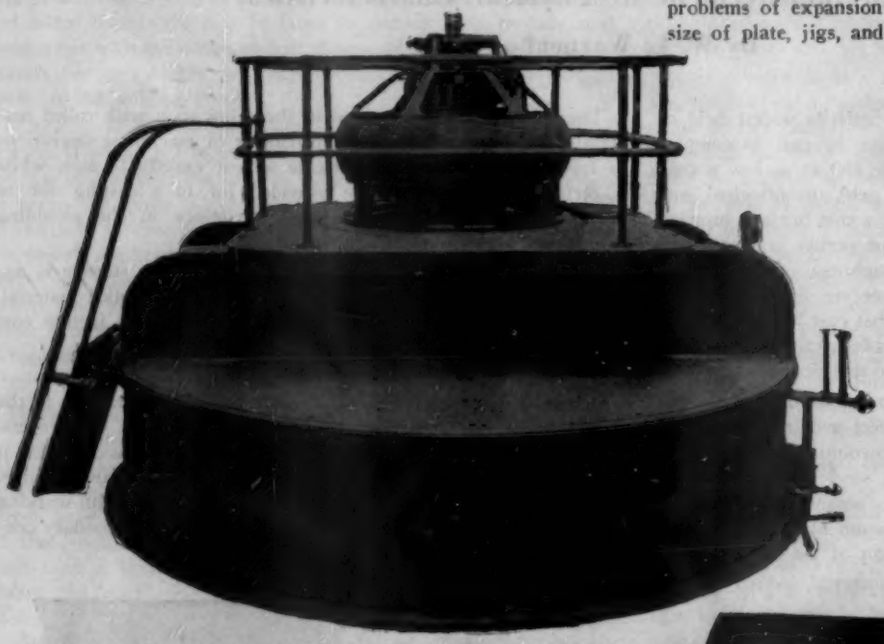


Fig. 5.—Vertical Waterwheel-Driven Generator With Welded Steel Frame and Exterior Bearing Bracket.

The use of antomatic welding machines for performing routine welding operations is always desirable whenever the nature of the product is such that the work of setting up does not consume more than approximately one-third of the total time required to complete the whole job. This condition is, however, relative only and should not be considered as a hard and fast rule. Figs. 1 and 2 show a method of replacing gear castings by rolled steel plate. The parts are cut from flat rolled steel plate by an automatic gas-cutting machine. The welding is done by automatic machinery.

Sometimes it is possible to build up forming dies for use in metal presses by welding. When this is done, considerable—if not all—machine work may be eliminated. Fig. 3 shows a welded bulldozer die. These replace more expensive cast steel and drop-forged dies.

One of the earliest changes from casting to welded steel construction was on the bases for arc welding sets as shown in Fig. 4. This type of construction is lighter and cheaper than the casting and stands up better under the rough service conditions to which these machines are subjected.

Perhaps one of the most interesting applications of welded structural steel parts to the replacement of castings is the work which the General Electric Company has been and is now doing with the stator frames of electrical machines. The following photos represent the result of several years' work.

A completely assembled vertical waterwheel-driven generator assembly necessitated a very careful study. These have, however, with welded steel frame and exciter bracket is shown in Fig. 5. Fig. 6 shows a synchronous condenser with welded steel frame and welded structural base.

It must not be supposed from the foregoing discussion that the substitution of welded fabricated shapes for casting is taking place without being confronted by complicated problems. The problems of expansion and contraction, type and design of weld, size of plate, jigs, and fixtures, amount of weld, and methods of been quite successfully solved, which is another proof that the old axiom, "Where there's a will, there's a way," still holds good.

From the illustrations above, it is evident that welding is making possible some very startling changes in methods of machine construction of various kinds. The activity in the structural steel industry at the present time is further evidence of the awakened interest in the possibilities of the welding processes which, after all, is but a new addition to iron foundry processes.

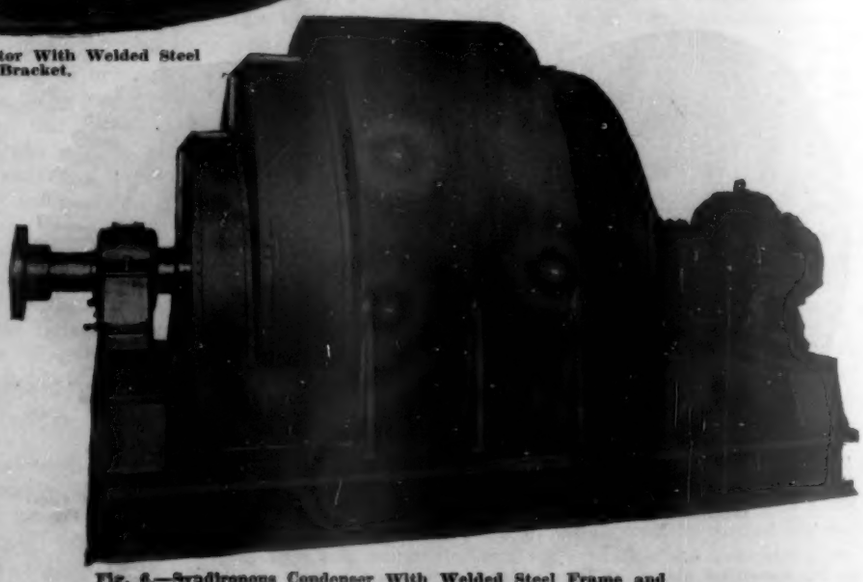


Fig. 6.—Syndironous Condenser With Welded Steel Frame and Structural Steel Base.

BIOGRAPHY OF A GREAT ENGINEER

The autobiography of Benjamin Garver Lamme, late chief engineer of the Westinghouse Electric and Manufacturing Company, has just been published by G. P. Putnam's Sons, New York City. As a sixteen year old boy Mr. Lamme received his first inspiration to the study of electricity by reading over the description of an Edison dynamo in a magazine. In less than sixteen years he had designed the great generators for Niagara, which were without precedent. His first major achievement was the design of a railway motor. As a result of a clear understanding of underlying principles he was able to produce a new type of motor whose outstanding features still persist as a standard after thirty-five years of service. He won a high place in the electrical engineering world by thorough engineering analysis and hard work. His own story of his life work is full of human interest. And the book which relates it is a highly inspiring volume.

WELDING RAIL JOINTS IS ECONOMY

T. M. Pittman, Roadmaster, Mississippi Division. I. C. R. R.

THE large increase in axle loads in recent years has focused the attention of trackmen to the already important problem of rail maintenance, especially the ends of the rails, or joints. Under the continued pounding of heavy wheels moving at high speed the ends of the rails are flattened out and cause what trackmen call battered joints. When the rails become battered it is difficult to keep the joints from settling and forming low places in the track. Consequently, the cost of maintaining such track in a smooth riding condition is greatly increased.

Before this condition became so extensive it was the practice to remove badly battered rails from the main track and use them on side tracks. Later on rail saws were established at central points where the battered ends of the rails were sawed off and the rails returned to service in main tracks where traffic was lighter. During recent years, however, the number of battered joints has increased so rapidly that too much expense was incurred by removing the rails from the track, and experiments were made toward restoring the rail to its original section under traffic without removing it from the track. This is now being accomplished by means of oxy-acetylene torches. The rails are heated to a red heat and shaped up with a flat-faced hammer. If any of the original metal has been lost by chips breaking out of the ends of the rails it is restored by welding additional metal with the torch. By this process one joint can be built up in from 20 to 25 minutes. Some badly battered joints require a longer time, but as a rule when it is decided that more than 45 or 50 minutes will be required the rails are sent to the saw. The joints do not batter uniformly, and some of them do not require treatment. The foreman of the welding gang and the track supervisors examine the joints carefully with a straight edge and mark the ones to be built up.

Work Begun in 1921

The first work of building up rail joints by welding on the Illinois Central System was done on the Minnesota division in 1921, and the results were so satisfactory that it was rapidly extended to 13 divisions. Welding gangs have now become a part of the regular maintenance organization on some of these divisions. During the past five years 176,000 joints have been built up on the Illinois Central System, at a cost ranging from 77 cents to $2.50 for each joint, or an average of about $1.33 each. Many dollars have been saved in rail renewals. With the extension of the practice the condition of the joints is rapidly improving, and before long the joints that are now being passed by in order to improve the ones that are more badly battered will be built up. As this condition improves the economy of the practice will be even further felt because treating the joints before they have become badly battered prolongs the life of the rails beyond what could be obtained if treatment had been deferred until the joints had become badly battered. It will also prevent the wear between the under side of the rail heads and the angle bars. We already have cases where rails that have been listed for renewals have been built up and left in the track with entire satisfaction, and there are indications of three or four years of additional service. With the treatment of the joints as soon as they begin to batter, the life of the rails will be increased possibly five or six years, while the cost of building up slightly battered joints will be only about one-half of the cost of building joints upon which we are now compelled to work.

Six in Each Gang

An economical gang is composed of a foreman, or lead welder, three welders and two helpers. Such a gang will use about 26,100 cubic feet of oxygen, 25,740 cubic feet of acetylene and 155 pounds of welding steel, and should build up about 1,500 joints over a distance of six miles each month at an average cost of about $1.33 for each joint, or a total monthly expense of less than $2,000.

Abstracted from Illinois Central Magazine.

ACETYLENE PLANT IN WELDED STEEL BUILDING

(From the Denver, Colo., Post)

The first steel skeleton building erected in Colorado without either bolts or rivets is being built at Fortieth and Wynkoop streets by the Colorado Compressed Gas company, acetylene gas manufacturers.

When completed at an outlay of $50,000, the structure will comprise the first unit of a plant which, in time, will be expanded materially.

Although not the largest of the factory buildings under construction or planned for Denver, the Colorado Compressed Gas Company structure is attracting attention of the building industry because of its design.

All Joints Are Welded Together

Every joint of the steel framework is welded together instead of being riveted. The process being used is known as electric arc welding. While new in building construction in Denver, the process has been thoroughly established and is used extensively in eastern cities. In Colorado its use is becoming more or less general in the fabrication of tanks, stacks and work of that character.

Steel work is being done by the Midwest Steel & Iron Works company, a local concern. Main beams of the steel skeleton were welded in the company's shops and all joints are fastened as the process of construction progresses on the building site.

The structure was designed and all of its engineering problems worked out by Robert K. Fuller, Denver architect.

Processed Metal Beats Insulation

"Experience has shown that certain types of structures are better adapted for the housing of plants manufacturing acetylene gas," said P. D. Gleason, local manager of the company.

"After a careful analysis it was determined our building should be of a structural steel frame work enclosed in a specially processed metal to afford the best insulation. To insure greatest stability and rigidness in the frame, the electric arc welding process was adopted. Bolts and rivets are entirely eliminated because the joints of the steel skeleton are welded together.

"The exterior covering is a processed metal made by combining sheets of steel, asbestos and asphaltic compounds. This is coated with aluminum. The aluminum deflects the sun's rays and the asbestos insulation keeps out the heat, which is a fundamental requirement of acetylene gas manufacture."

WANTS EDUCATIONAL LITERATURE FROM MANUFACTURERS

Roy Thomas, 1637 E. Vernon Avenue, Los Angeles, California, heads the welding organization known as the "Certified Order of Welders," which was recently formed in that city. In a letter to *The Welding Engineer* he states that the organization has made very satisfactory progress as indicated both by rapidly increasing membership and also by the fact that oil companies come to their organization to get welders. Employment headquarters are maintained both at Los Angeles and at Long Beach. The organization is starting to build up as complete a library on welding as possible, and Mr. Thomas writes that they will be glad to receive educational literature from manufacturers to add to this library.

BOOKLET ON LINCOLN ARC WELDING PRIZES

The American Society of Welding Engineers has issued a booklet giving complete information and rules for the competition in connection with the $17,500.00 given by the Lincoln Electric Company of Cleveland, Ohio, to be awarded to those contributing the best three papers disclosing new information to advance the art of welding. Those who are interested in this prize contest should request a copy of this booklet from D. W. Rice, Secretary, American Society of Mechanical Engineers, 29 W. 39th St., New York City.

LEHIGH CONDUCTS WELDING SYMPOSIUM

New Problems in Structural Fabrication Discussed at Well-Attended University Meeting.

Several score members of the Lehigh Valley Engineers Club, in addition to practically the entire engineering student body, attended the sessions of the Welding Symposium held at Lehigh University, Bethlehem, Pennsylvania, Monday, April 4th. This meeting, which was planned and directed by a committee of which Professor Ralph J. Fogg, Head of the Department of Civil Engineering, was Chairman, covered the matter of welding in construction and repair from many important angles. In an introductory discussion of the general subject, Professor Bradley Stoughton described the various processes of welding and following this the physical characteristics of joints made by all of the various welding processes were demonstrated by testing of actual specimens at the Fritz Laboratory.

This testing, which was done in the presence of the audience, involved stressing welding coupons made by the oxy-acetylene, electric arc, electric resistance and thermit processes to destruction and plotting the results of these tests.

An outstanding feature of this work was the testing of a structure built up of two 10 inch H columns and two 12 inch I beams. This was tested in compression, the failure coming in the buckling of the web in the upper member. Stresses induced by this failure thrown into the weld caused final failure through the weld metal as expected.

An afternoon session was devoted to demonstrations of welding by the various commercial methods.

At the evening session Professor F. P. McKibben, formerly of Lehigh University and Union College, defined the present status of welding. Messrs. Lang and Smith of the Lincoln Electric Company, discussed the use of welding in structural steel work and Mr. A. F. Jensen of the Hannan Engineering Works, Chicago, read a prepared paper in rebuttal, "This Is the Age of Riveted Steel." The discussion which followed these papers brought out many facts which emphasized the dependability of a properly designed and properly executed weld made by any of the various methods in commercial use.

CARNEGIE INSTITUTE BULLETIN ON PLUMBING, HEATING AND VENTILATING

Published proceedings of the third annual three-day institute for the plumbing, heating and ventilating industries held under the auspices of the Carnegie Institute of Technology in Pittsburgh on January 18, 19 and 20, 1927, are now available in bulletin form, according to an announcement.

Lectures delivered by members of the faculty of the institution are published in full, and several of them are illustrated. The contents include "Business and Salesmanship," by Dr. Walter F. Rittman, professor and head of the Department of Commercial Engineering; "Corrosion of Metals," and "The Welding Process," by Robert B. Leighou, professor and head of the Department of Industrial Science; "Welding in the Plumbing and Heating Industry," "A Proposed Program for Plumbing Research," and "The Plumbing Code," by Samuel E. Dipple, holder of the Theodore Ahrens Professorship in Plumbing, Heating and Ventilating; "Plumbing and Heating Installation in Building Construction," by Clifford G. Dunnells, professor and head of the Department of Building Construction; "Water Supply and Sewage Disposal," by Harold L. Lang, professor of biology and public health; and "Health As It Is Affected by Plumbing, Heating and Ventilating," by Dr. H. Ryerson Decker, consulting physician.

Copies of the bulletin are available to those interested at one dollar ($1.00) each.

CANADA'S FIRST STEEL AND POWER SHOW

To bring under one roof, authoritatively, the best that modern ingenuity offers in equipment for industry, and to enable industry's executives and workers to hear vital subjects discussed in an informative way by men who know, is the primary object of Canada's first steel and power show to be held in the new Varsity Arena, Toronto, on August 31, September 1 and 2.

Sponsored by Canadian organizations in the fields touched, the exposition is backed by the 1550 members of such well-known societies as the Montreal and Toronto chapters of the American Society for Steel Treating; Canada Council, Toronto Council and Hamilton Council of the Universal Craftsmen's Council of Engineers; Toronto, Hamilton and the Dominion executive of the Engineer's Mutual Benefit Fund, and the Toronto branch of the American Electro-platers' Society.

In the exhibits, many of which will be in operation, will be featured the use of metal working, heat treating, materials handling, welding, power generating, refrigerating, ventilating, and electrical equipment. High speed, carbon and alloy steels, bearings, refractory and heat insulating materials, packing, water treatments, fuel and lubricating oils, will also be displayed to show the savings possible from their proper use.

Throughout the three days, technical sessions will be held at which papers will be delivered by recognized authorities on the subjects featured in the exhibits.

ANNUAL MEETING OF A. W. S.

The Eighth Annual Meeting of the American Welding Society will be held in the United Engineering Societies Building, 33 West 39th Street, New York, N. Y., April 27, 28 and 29.

The program has been announced as follows:

Wednesday, April 27, 1927—American Bureau of Welding and Committee Meetings:

Morning 9:30 A. M. Gas Welding Committee

Morning 9:30 A. M. Electric Arc Welding Committee

Afternoon 2:0 P. M. American Bureau of Welding.

Thursday, April 28, 1927—Technical Sessions:

Morning 9:30 A. M. Report of Tellers Committee. A symposium of Research Activities in the Welding Field during past three years.

Afternoon 2:00 P. M. A Symposium on Production Welding.

Note: For the accommodation of members and their guests attending these sessions, a luncheon has been arranged at the Engineer's Club.

Evening 6:30 P. M. Dinner Dance.

Friday, April 29, 1927—Board of Directors and Committee Meetings:

Morning 9:30 A. M. Meeting of Board of Directors, A. W. S.

Afternoon 2:00 P. M. Joint Pressure Vessel Committee.

Special entertainment for lady visitors registered:

Wednesday, 12:30 P. M. Luncheon at the Hotel Commodore to be followed by matinee at Roxy's Theatre.

Thursday, 3:00 P. M. Bus ride.

CLEVELAND ENGINEERING EXHIBIT

Metallurgical Equipment and Materials is the specialty for the month of April at the continuous exhibit operated by the Cleveland Engineering Society. This is an educational exhibit in which many of the leading manufacturers of the country are displaying their products for the information of engineers, metallurgists and industrial executives of the Cleveland district. The exhibit hall is located on the top floor of Carnegie Hall adjacent to the club rooms of the Cleveland Engineering Society where many of the local sections of national societies are holding their meetings. The hall is open to the public every day from 8:30 a. m. to 8:30 p. m.

Several meetings along metallurgical lines will be held in the exhibit hall during April.

DENVER OPPORTUNITY SCHOOL BOOKLET

A twenty-six page booklet has just been issued by the Denver Opportunity School, Denver, Colorado. It gives in a brief, concise form a description of the school, its courses, its methods of instruction and administration and the spirit of the institution. One of the popular courses at this school is the course in welding and for several years this particular welding school has had a reputation for being one of the best in the country. A very complete welding course is given and the graduates of this course are in great demand in all industries which have use for the welding processes.

STRUCTURAL ARC WELDING EXPLAINED TO WESTERN SOCIETY OF ENGINEERS

At the regular meeting of the Western Society of Engineers held Monday evening, April 11th, Mr. G. D. Fish, consulting designing engineer for the Westinghouse Electric and Manufacturing Company, gave an illustrated talk on the subject of arc welding of structural steel. The keen interest in this subject was shown by the fact that the hall was more than filled to its capacity. Mr. Fish explained the applications of arc welding to heavy structures which preceded its application to the actual construction of buildings, then went into the detail of the tests which were conducted at Carnegie Institute last summer as the preliminary to the construction of a five story steel building for the Westinghouse Electric and Manufacturing Company at Sharon, Pennsylvania, by the American Bridge Company. The significance of the change in design from riveted construction to welded construction was explained and the importance of the tests as determining the advantages of welding for structural steel erection were demonstrated. The speaker then used the black board to discuss the engineering phases of welded design, and then showed a series of pictures taken at the building in Sharon, Pennsylvania, during the process of erection and also of an interesting test which was applied to the completed structure. The reading of the paper was followed by a long and interesting discussion of the application of arc welding to structural steel, the discussion consisting chiefly of answers to questions raised by engineers in the audience.

A. B. C. HEADQUARTERS MOVES TO NEW BUILDING

Chicago, April—The Audit Bureau of Circulations is now engaged in moving its headquarters from the Century Building to the eleventh floor of the new Builders' Building, Wacker Drive and La Salle Street. Movers began to pull down the machinery in the printing plant on March 26 and the complete transfer of all equipment will be accomplished by April 16.

The A. B. C. is the co-operative organization to which practically all the worthwhile publications of Canada and the United States belong and through which they report to the advertising world regarding the size and distribution of their circulations and their methods of winning and holding subscribers. In addition to the publisher members, of which this publication is one, the Bureau has in its membership most of the great national advertisers and important advertising agencies of the continent. Its managing director is O. C. Harn, for 21 years advertising manager of the National Lead Company.

The Builders Building is one of the great new structures which were started before the completion of Wacker Drive, an upper-level thoroughfare running along the southern shore of the Chicago River, which is recognized as the most desirable location for office buildings in the business section. The builders of Chicago united to erect the structure and it is looked upon as one of the finest and best arranged in the city. The Bureau's lease will run for six years.

This move will be in keeping with the rapid expansion of the Bureau and will add to its efficiency. For the first time in its 12 years, it will have its entire plant—its printing shop, its mimeographing room and its general office—on one floor. Its printing shop has been housed in the Rand-McNally Building about half a mile from the Century Building. The mimeographing room has been on the floor above the general office, requiring many trips up and down stairs daily. Furthermore, the new offices will be much more commodious than the old.

SEES GREAT FUTURE FOR WELDING

J. L. Fosnight, Sales Manager for the U. S. Light and Heat Corporation, Niagara Falls, N. Y., recently returned to his office after an extended trip through the central West and the oil field district of the central South. In the course of an interview with a representative of *The Welding Engineer*, Mr. Fosnight spoke in glowing terms of the great future which is obviously ahead of the welding industry. "When great corporations are willing to place orders for large quantities of welding equipment," says Mr. Fosnight, "there can be little doubt about their faith in welding and its advantages. In recent months two large orders of this sort have been shipped to two of the largest industrial organizations in the country. One of these was a shipment of 32 of our late model 300 ampere capacity arc welders to the Rock Island Railroad at Chicago. The other is a shipment of 20 of our machines to the Willis-Overland factory. Such a wholesale acceptance of arc welding by organizations who are known to have complete facilities for testing the possibilities of any manufacturing process is in our estimation very significant. Throughout the oil field district during the past month I have noticed the same sort of confidence in welding. Anticipating that the demand for equipment will continuously increase, we have been appointing district managers in many important cities in the central South. Appointments have already been made in Tulsa, Dallas, Amarillo, Houston, St. Louis and Kansas City and we expect to make more of them. In fact we are convinced that the demand for welding is just beginning to grow therefore we are going ahead just as rapidly as possible in the development to take care of this demand as it does grow."

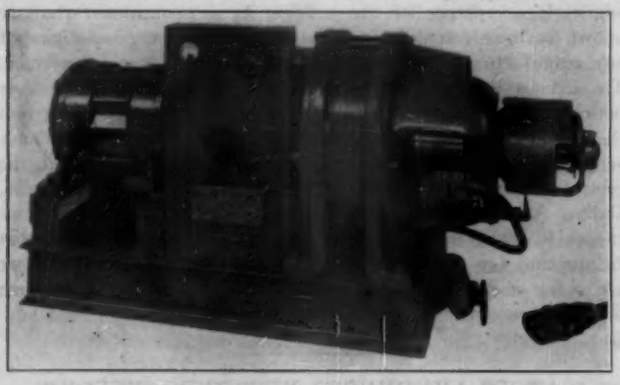
WATERS ANNOUNCES NEW TYPE WELDER

The Waters Arc Welding Corporation, 617 Tenth Avenue, New York City, manufacturer of arc welding equipment, have just placed on the market a new addition to their line, particularly adapted to use in the automotive industry. This machine,

here pictured, can be used for the following purposes: (1) Electric welding of automotive parts of cast iron, malleable or steel without pre-heating. (2) Testing for grounds or short circuits in electrical wiring systems of automobiles. (3) Testing of fuses. (4) Electric soldering attachment for instantaneous soldering. This arc welder is called the Midget Automotive Welder. The complete Waters line now includes eleven different sizes of machines.

NEW HOLLUP ARC WELDER

The C. H. Hollup Corporation of Chicago, manufacturers of the well known Wanamaker coated electrodes, has recently put on the market a new D C arc welder which will be called the Hollup Arc Welder. The generator can be driven either by motor or gasoline engine and the outfit can be furnished for either stationary or portable service. The welding unit as furnished is mounted on a welded structural steel base with a single control panel of steel mounted on it. The company emphasizes the compactness of the outfit and the ease of handling obtained by pro-



New "HOLLUP" Arc Welder.

viding a single heat control adjustment. A special connection plug and receptacle has been provided, which simplifies connecting and disconnecting the welding leads and makes it easier to reverse the polarity on the machine. Ball bearings are used throughout the electrical units and roller bearings are used on all trucks. An automatic start and stop control is provided. No current carrying parts or switches are exposed and the machine has automatic no-voltage and overload protection. This welder is said to have full capacity for all ranges of arc welding from light to heavy.

A NEW WELDING ENGINEERING SERVICE

A number of engineers, mostly connected with the Chicago Steel and Wire Company, manufacturers of Weldite Welding Rods, have incorporated the Fusion Welding Corporation. It is the intention to furnish a free service in Redesign Engineering, based on the principles outlined in the article by J. B. Green appearing elsewhere in this issue. The new company has for sale a full line of equipment and supplies for fusion welding and cutting. The introduction into industry of new materials and methods is continually calling for new sorts of welding to meet all kinds of extreme conditions. There has appeared a keen demand for welding to withstand elevated temperatures, chemical corrosion, unusually high tensile strength or elongation, resistance to abrasion; for it to be light weight; to have high electrical conductivity, or possess non-magnetic properties. Under certain conditions extreme welding speed is required or the substitution of one metal for another retaining or improving on the original properties.

The staff of the Fusion Welding Corporation announce that they are prepared to undertake the solution of problems of consequence along these lines. This free service is strictly an engineering one and does not include design drafting or other matters of a similar sort. An announcement booklet telling more of the activities of the new company and describing some of the apparatus and supplies for arc welding which are offered for sale may be obtained on request to the Fusion Welding Corporation, 103rd Street and Torrence Avenue, Chicago, Illinois.

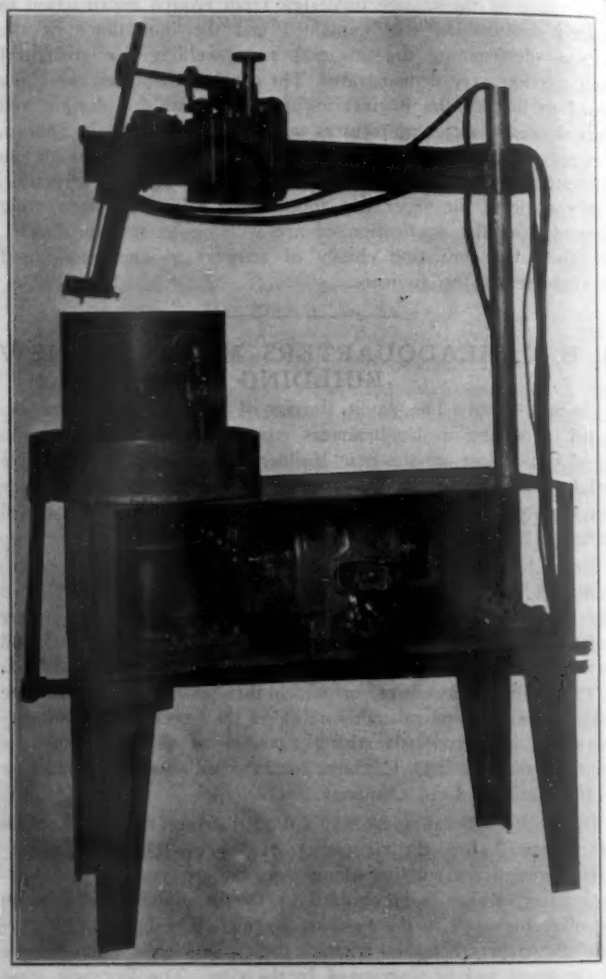
REBUILT RESISTANCE WELDERS

Taylor-Hall Welding Co., 7 May St., Worcester, Mass., announces that it is selling rebuilt butt and spot welders with guarantee against any defects, and is prepared to supply requirements throughout the United States for these welders. This company is also sales agent for Thomson Electric Welding Co., for the Southern New England territory. Job welding is also done on a contract basis.

NEW LINCOLN WELDER MAKES WELDS UNDER WATER

Rapid extension of the field of usefulness of electric arc welding has induced manufacturers of this type of equipment to bring out many new and interesting welding machines. The accompanying illustration, showing a new carbon arc welding machine built by The Lincoln Electric Company, Cleveland, Ohio, is an example of one of the latest machines of this type.

The automatic arc carbon welding machines have been recommended for welding of pieces in which no preparation of the edges to be welded is made. The machine shown is made to weld circular seams up to twelve inches in diameter. A particular feature of the machine is the cooling tubs around the revolving table which carries the piece being welded. The piece on which

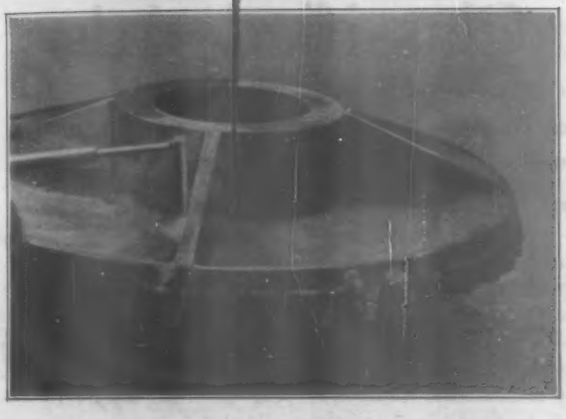


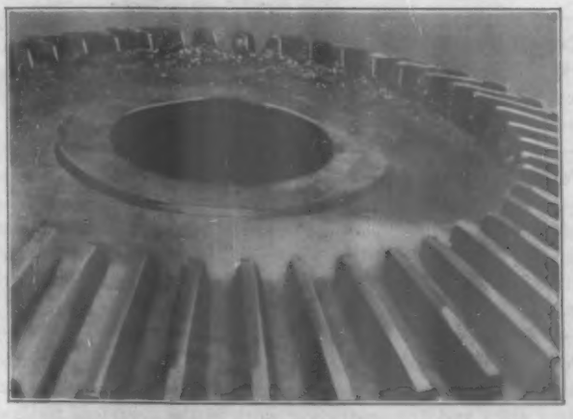
the welding is being done may be partially or totally immersed in water during the welding operation. Cooling water is in circulation in the tubs during operation.

The novel cooling arrangement used on this equipment was developed to meet the requirements when welding high grade alloy steels on which the heat disturbance due to application of welding heat must be reduced to a minimum. In the case of 12 percent manganese steel the manufacturers state that the welding may be done with the piece totally immersed in water and the arc submerged. This cooling arrangement is well adapted to the welding of manganese steel since the rapid quenching of the molten metal gives it the physical properties expected in 12 percent manganese steel.

The frame and details of the machine are all made of welded steel construction and the machine itself is an excellent example of the rapidly growing tendency to use welded steel construction in place of gray iron castings.

TOBIN BRONZE WELDING





1½ ton bevel gear of a pulp press in a California beet sugar factory Tobin Bronze welded.

Reclaimed this cracked gear at one-fifth the cost of a new casting

IT would have cost $500 to replace this 1½-ton casting. Tobin Bronze Welding repaired it for less than one-fifth of that cost. One welder and his helper "veed" the cracks on both sides in about five hours and did the welding job in five more.

Tobin Bronze has such a low welding temperature, 1650° F., that extensive pre-heating was not required. As a result the risk of distortion and metal shrinkage was avoided.

Cast iron properly welded with Tobin Bronze will not break at the weld because Tobin Bronze permeates the iron and knits the broken parts together in a permanent bond stronger than the original casting.

Many manufacturers who have proven the value of Tobin Bronze Welding for repair work are now using it to save time and money in manufacturing operations.

THE AMERICAN BRASS COMPANY
GENERAL OFFICES, WATERBURY, CONNECTICUT
Offices and Agencies in Principal Cities
Canadian Mill: ANACONDA AMERICAN BRASS LIMITED, New Toronto, Ontario

TOBIN BRONZE

REGISTERED U.S. PATENT OFFICE

WELDING RODS

EXCLUSIVELY AN ANACONDA PRODUCT

NEWS OF THE WELDING TRADE

The Pittsburgh office of the Burke Electric Company of Erie, Pennsylvania, has been moved to 2124 Farmers Bank Building, Pittsburgh. W. F. Wallace is in charge of the Pittsburgh office.

The Federal Machine and Welder Company of Warren, Ohio, has purchased ground on which to build an addition to their present factory. It is reported that the new building will provide an increase in their manufacturing facilities of about 100%.

The Pioneer Welding Company, Kalamazoo, Michigan, are manufacturing for the welding trade a metal truck for carrying a complete oxy-acetylene outfit.

A. H. Peir Company, distributors of Lincoln Arc Welders for southern California, have taken larger office and warehouse space in the Star Building, 1855 Industrial Street, Los Angeles. The company enjoyed a very prosperous year in 1926 and report a considerable increase for the first three months of this year compared with the same period for the past year.

Mutual Auto Specialties, Incorporated, manufacturers of Lightning flux powder, for all metals, are moving to new quarters and will be located at 47 Sixteenth St., Pittsburgh, Pennsylvania, after May 3rd, 1927.

G. O. Carter, Consulting Engineer for the Union Carbide and Carbon Corporation, gave an illustrated talk entitled "Behind the Scenes in Chemical Production" before the meeting of the American Institute of the City of New York, on April 7th. Mr. Carter was formerly president of the Association of Chemical Equipment Manufacturers.

It is reported that the Torch Parts Company, 2440 W. Superior Avenue, Cleveland, Ohio, has been absorbed by the Torch Parts Air Appliance Company, 2100 W. Superior Avenue, Cleveland. The concern is under the management of J. R. Rose and A. E. Slinger.

The Keith Dunham Company, Chicago, Illinois, needing more space on account of the rapid extension of its business, recently moved to new and larger quarters on the fifth floor of the Westminster Building, 110 South Dearborn Street, Chicago.

According to a recent report the Linde Air Products Company, 30 E. 42nd Street, New York, manufacturers of industrial oxygen, will soon start construction of a new oxygen producing plant at Amarillo, Texas.

K. L. Hansen, Electrical Engineer and designer of the Hansen arc welder, made by the Northwestern Manufacturing Company of Milwaukee, Wisconsin, was one of the speakers at the meeting of the American Welding Society, Los Angeles Section which was held March 31st. A motion picture dealing with the manufacture of steel was exhibited by the Linde Air Products Company at the same meeting.

The Smith Welding Equipment Corporation, Minneapolis, Minnesota, has just issued a new 1927 junior catalog. It is a convenient pocket size. It illustrates, describes and gives prices on oxy-acetylene equipment for quite a variety of uses. The information contained in it fills thirty-two pages.

Mr. R. P. Kanski has been appointed sales representative for USL Arc Welders in the territory of Brooklyn, N. Y., operating under supervision of the New York office of the U. S. Light & Heat Corp.

J. F. Lincoln, of Lincoln Electric Company, Cleveland, Ohio, is scheduled to read a paper on electric arc welding before the spring meeting of the A. S. M. E. at White Sulphur Springs, W. Va., on May 25.

Stulz-Sickles Company, Newark, N. J., distributors of Seaco gas and electric welding rods, report substantial increase in business for this year over corresponding period of 1926. This company supplied welding wire for use at the new East River Station of the New York Edison Company, at 14th Street and East River, New York City, where Seaco grade C rods aided in the welding of parts of stacks, coal hoppers, special lug work on boiler installations, etc. The welding work at this generating plant was reviewed in detail in the March issue of *The Welding Engineer*.

The Colorado Compressed Air Co., 2101 Blake Street, Denver, Colo., Philip D. Gleason, manager, is planning the early erection of a new plant at Pueblo, Colo., to cost about $100,000 with equipment.

Classified Ads

Help Wanted—75c per line, minimum 4 lines.

Jobs Wanted—4 lines free.

Other Ads—$1.00 per line, minimum 4 lines.

Counted 8 words to line. Add 6 words for keyed address

For Sale—25 Lincoln arc welders in perfect condition at a saving of approximately $500.00. Subject to prior sale. U. S. Light & Heat Corporation, Niagara Falls, New York.

Position Wanted—Oxy-Acetylene welder, beginner, three years mechanical work. One year electrical work. Address Frank L. St. Clair, Lecompton, Kansas.

Experienced Welder—Gas and electric, desires any kind of work. Will leave state for permanent position. A-1 references. Address V. W. Andrews, 181 Fulton Street, Medford, Mass.

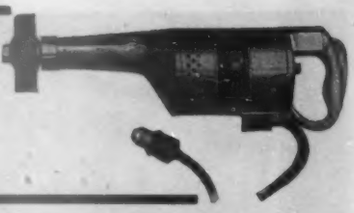
For Sale—U. S. and Foreign Patents, of attachment to oxy-acetylene torch, fits any make, cuts any shaped hole, round or square, vertical or bevel. Micrometer adjustment, weight 11½ lbs. Ideal line for light manufacturer. No competition. Address Paul Orzel, 670 E. 170th St., New York City.

Position Wanted—Young man, 7 years in the steel barrel industry, 4 years as plant superintendent; must make change. Desires sales and demonstrating work in the acetylene welding equipment field. Have been connected with the welding industry for 10 years; experienced on pipe, repair and manufacturing production welding. Feel that my experience and executive ability will be a considerable asset in the selling field. This ad has the sanction of my present employers. Address 420 Smith St., Niles, Ohio.

Position Wanted—In order to gain more experience. Have about six months welding and brazing experience. Prefer shop where all kinds of welding is done. Address Paul Lynch, Jr., 128 So. Canal St., Chicago, Ill.

Wanted—50 welding and cutting outfits; also electric welders and welding supplies. Must be cheap. Address Box 113, care The Welding Engineer.

Wodack Grinders Make Welding Cheaper



Any kind of a weld in any position is easily prepared with the WODACK Portable Electric Grinder. No lifting of heavy pieces, no slighting of work because of hard positions. The WODACK gets at the job and gives you clean metal to work on, shortening the welding time and reducing gas consumption. Read about this grinder in "Electric Tool Facts." We'll be glad to send you a copy.

Wodack Electric Tool Corporation

63 S. JEFFERSON ST. CHICAGO ILL.

"STANDARD" Welding Wire
GAS AND ELECTRIC

for sound permanent welds : : lower costs—everlasting satisfaction

Made in our own mills by specialists in welding wire manufacture
A grade for each type of work—send for samples.

Standard Steel & Wire Co., Greensburg, Pa. (Mills at Bolivar, Pa.)

Wanted—The address of every gas and electric welder in the United States. Send them to Knight Brothers, 113 S. Oakley St., Chicago, Ill.

For Sale—Old established welding shop for sale by owner. Only exclusive welding shop in 300 mile radius. City of 25,000; many industries; no competition. Latest and best electric and gas equipment. Good welder can make shop pay two men a good salary and pay for itself first year. Address Box 115, care The Welding Engineer.

REBUILT WELDING SETS IN STOCK

All of these sets are guaranteed to be free from electrical and mechanical defects.

C & C 60 volt 300 ampere generator	$ 150.00
C & C 60 volt 200 ampere generator	125.00
G. E. 60 volt 300 ampere generator old style no switchboard	175.00
Bogue 50 volt 200 ampere generator and switchboard	150.00
200 ampere G. E. complete with switchboard and base but without motor	200.00
300 ampere G. E. complete with switchboard but no motor base	250.00
Waters machine overhauled and licensed	250.00
Quasi-Arc 110 D.C. only new style	250.00
Quasi-Arc 110/220 D.C. only old style	175.00
ZEUS 300 ampere oil cooled 440 volts licensed	200.00
ZEUS 300 ampere oil cooled 220 volts	250.00
ZEUS air cooled never used 200 amp.	350.00
Allen Semi-Arc machine 220 volts	150.00
Steinboch A. C. machine 150 amp.	100.00
Rebuilt ALTERNARC "COMMERCIAL"	350.00
Rebuilt ALTERNARC STANDARD WELDER	450.00
One new UNIVERSAL "COMMERCIAL" at the plant of the Interstate Sheet Metal Company, 391 Mulberry Street, this city, for price get in touch with them direct. Also, one at Ironwood Machine and Welding Shop, Ironwood, Mich.	
4 ball-bearing Wilson with matched motor and generator 300 amps. 220 volt D.C. motor	500.00
400 amp. Westinghouse Foundry type 50 to 75 volt with 30 H.P. A.C. motor but can be connected for 220-440 2 or 3 phase, now connected 440 3 phase. Price arranged for two men welding or one man cutting	400.00
400 amp. dynamotor with 1½" shaft extension so that it can be driven externally or 15 horse motor can be used to drive anything, but was made originally to give 50 volts D.C. from 220 volt D.C. source complete on base with wheels and chassis, tong and steering arrangement. This set is absolutely new, it has never been used and is ball-bearing.	550.00
500 ampere two man welding one man cutting DUALARC, with 220-440 A. C. motor and separate 220 D.C. motor, ball-bearings on generators and both motors, six ball-bearings in all with base, separate control of volts and amperes, switchboard, etc., complete with one motor	900.00
Complete with two motors	1000.00
One DUALARC set absolutely new except has been rented	700.00
One Gas Engine set complete with air compressor guaranteed as new.	1100.00
One DUALARC Gas Engine set on Ford Truck—truck and all	1250.00
One gas engine set with air compressor large enough for riveting with 1½ ton new truck, used 3 months, overhauled and guaranteed as new	1750.00
One DUALARC set rebuilt with new parts and guaranteed	950.00
DUALARC generator complete with switchboard for gas engine drive	500.00
One U. S. L. gas engine with Buda motor on G. M. C. truck	1000.00

Also one Lincoln, one Wilson 25 cycle, 200 ampere and one Wilson 60 cycle, 600 ampere and one C. & C., 600 amp. two commutator machine.

All of these machines subject to prior sale.

ELECTRIC ARC CUTTING & WELDING CO.,
152 Jeliff Ave., Newark, N. J.

For Sale—Service rights on WK and WC Prest-o-Lite cylinders, large or small quantities. Alfred E. Corp., 40 Mathewson St., Providence, R. I.

WELDING ROD HOLDER
FOR THE OXY ACETYLENE WELDER
$1.00
ALL STEEL WIRE BRUSHES
SEND $1.00 FOR 5 ASSORTED BRUSHES
Money refunded on return of goods, if not what you want.
WRITE FOR DEALERS' PRICES
C. SORENSEN, 18 E. 16th ST., CHICAGO

ELECTRIC WELDING MACHINES

In addition to our regular stock we have just added the following:
7— 200 amp. Lincoln welders, a. c. motor drive.
1— 200 amp. U. S. L. welder, gasoline engine drive.
1—1000 amp. Westinghouse welder, a. c. motor drive.
3— 200 amp. transformer type welders.

GOODMAN ELECTRIC MACHINERY CO., 126 Green St., Newark, N.J.

U. S. Light & Heat Corporation, Niagara Falls, New York, wish to engage a welding engineer who is qualified to instruct distributors in the applications of arc welding. Please give full information regarding your past experiences.

Butt REBUILT WELDERS Spot

Guaranteed to be in Perfect Condition

One Thomson 75 P. A. Spot Welder.
One Toledo 110 Spot Welder.
One Thomson 40-A Butt Welder.
One Thomson 20-A Butt Welder (New).
One Toledo 3 Butt Welder.
One Thomson 10-A-6 Butt Welder.
One Thomson 2-A Automatic Butt Welder.
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One Thomson 2-A Hand.

Many Others. WRITE.

TAYLOR-HALL WELDING CO., 7 May St., Worcester, Mass.

Position Wanted—Graduate engineer, 30 years old, 8 years manufacturing experience, 5 years assistant superintendent of large pipe and tank manufacturer making electric welded steel pipes and tanks from 14 gauge to ¾ inch thickness. Thoroughly familiar with both hand and automatic welding. Address Box 116, care The Welding Engineer.

For Sale—One Seneca Arc Welder Transformer Type, $125.00. 7,000 lbs. Armco Gas Welding Wire ¼ inch and 2,000 lbs. $\frac{1}{16}$ inch Armaco Electric Welding Wire in coils, 3c a pound. Standard Welding Company, 1609 Elston Avenue, Chicago, Ill.

For Sale—Completely equipped shop for welding, brazing, auto radiator repairing, auto body work and general auto repairing, located at Monessen, Pa. Good reason for selling. Write for price and details. Box 114, care The Welding Engineer.

WISSCO GRADE NO. 2 SPECIAL. PROCESSED ELECTRODES
Developed for particular consumers; i. e. Railroads, Shipyards, Boiler Makers, etc., for use on general repair work.

NO RIVETS--NO FITTINGS ONLY WISSCO WELDS ON THIS LARGE TANK AND PIPE LINE

An ice plant with a capacity of 500 tons is being constructed for the Canadian Government at Toronto, by the Carbondale Absorption Machine Co. Ltd., of Montreal.

The ice tank, 70′ by 32′ by 5.5′, of ¼″ plate, has just been completed. No rivets were used and no standard tees were employed as fittings; the entire job, including all cross lines from the main line, was electrically welded by the Thompson Welding Co., Limited, of Toronto, with Wissco No. 2 Special Processed Electrodes. A pressure of 180 pounds is required in the ammonia line, and the welds were tested to stand a pressure of 300 pounds.

Each grade of Wissco Welding Wire is composed of special analysis, especially processed wire produced for a certain type of welding.

All Wissco Welding Wire is tested for chemical, physical and welding properties before being passed. Uniformity and proved welding ability are thereby insured.

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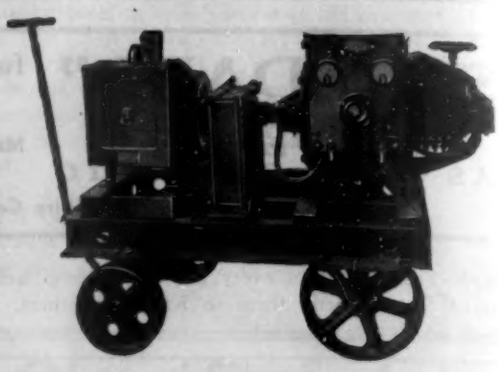
Wickwire Spencer Steel Co.,
Dept. 4-WE, 41 East 42nd St., New York City.
Please send me your booklet "Wissco Welding Wire."

Name ..... Address .....

WICKWIRE SPENCER PRODUCTS

Prices below Value
on New G. E. Arc Welders



Generator wound 75/300 amperes, 40/20 volts, Motors wound 10 H.P., 220 volts, 3 phase, 60 cycles, also 220 volts, direct current.

General Electric Co. New Type F Electrodes carried in stock for immediate delivery.

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Welding Rods for Every Purpose

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"Colo[illegible]apt"

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WILLIAMS

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WELDING WIRE

ELECTRIC and GAS WELDING WIRE

High-Grade
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Immediate Shipment from Warehouse

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WELDING SUPPLIES
925-935 Pennsylvania Avenue, Pittsburgh, Penna.

"Note the name Weldflo *Each rod the same"*

Representing: TORCHWELD EQUIPMENT CO.

Over 8 Years of Service— Not One Sign of Deterioration

If the filler of an acetylene cylinder is made of inferior materials and is poorly constructed, it soon sags. As a result, it becomes unsafe and must be taken out of service.

Users of Hackney Cylinders are never troubled with such results.

In 1924 a gas producer found that some of his Hackney Cylinders, manufactured in 1916, had accumulated as high as 10 pounds of water. This was caused by the lack of driers in his compressing units.

He devised a method of extracting this water, and in order to determine what effect it had on the asbestos filler, a number of cylinders were sectionized both before and after the extraction process.

It was found that the core had in no way deteriorated. There was no sagging and no breaking down of the structure. And these Hackneys all had records of over 100 fillings each.

This specific instance is a good example of the safety and dependability of Hackney's asbestos core. And it shows one more reason why 99 7/10% of the 70,000 Hackney Cylinders manufactured in the last 15 years are in active service today.

Write for Information.

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MILWAUKEE, WISCONSIN

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Carbic

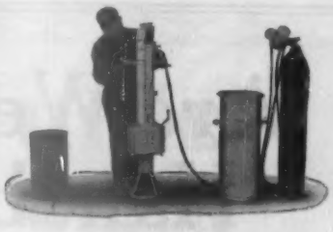
TO CHARGE

SAFE-

FILL TANK WITH WATER TO WATER LINE

PURER PORTABLE CHEAPER

INSERT CARBIC CAKES IN CAKE HOLDER



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ACETYLENE IN SIMPLIFIED FORM

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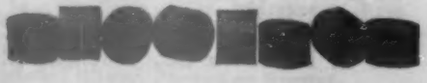

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A Triumph in light torch construction

Torchweld has just developed a light, perfectly balanced torch for average production and repair work. The one piece tip eliminates chances for gas leaks, and repair bills. Every permanent joint is brazed and every valve is accurately machined to assure absolute tightness. It produces an unchanging, soft, neutral flame for continuous service, and it cannot flash back. Let us send complete details.

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Complete 22NF Unit Including 2 Regulators, Hose and Accessories $75

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BY C. J. HOLSLAG

A simple and practical manual of instruction in arc welding. The beginner is led step by step to complete mastery of the process. The supervisor is furnished a reliable guide for the training of new operators. The experienced operator is posted on principles which were overlooked in his first teaching.

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A Practical Book on Welding

Written by seasoned Welders—specialists in Welding and metals—in the language that Welders know. It contains a wealth of practical facts about Gas and Electric Welding, money making suggestions regarding specific Welding problems. An almost unlimited fund of knowledge and experience behind each recommendation.

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We recently demonstrated one of our welding outfits in one of the leading welding shops in the city of Detroit, and issued invitations to more than a score of the best qualified men in town to witness the demonstration. After this demonstration, we contracted orders totaling 120 machines for Detroit. May we demonstrate the Seneca for you?

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Immediate Shipment From Cleveland and Newark Warehouses

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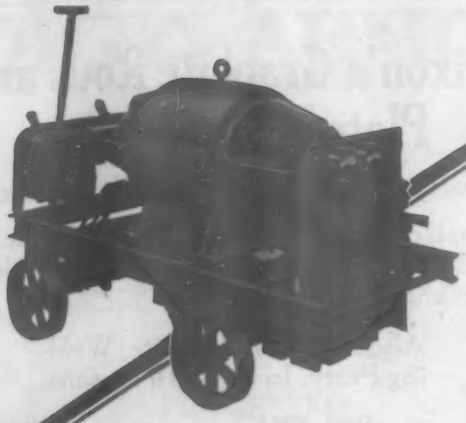

Type A3—75 to 300 amps.
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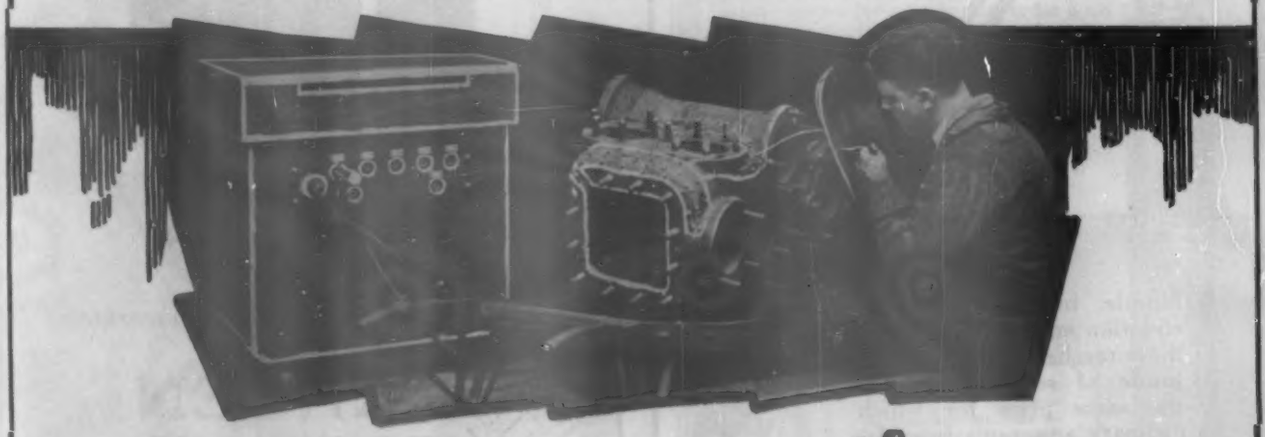

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But you will find in all styles and all sizes of K-G torches the same unvarying qualities:

Efficiency
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ONCE the operator has adjusted the flame on a K-G torch correctly and puts the torch to work, **it stays at work.** Flashbacks and flame variations, costly in their loss of gas and time, cannot occur with K-G torches. A special K-G feature is the single seating of the tip. It prevents gas leakage. You should investigate this.

Simple, but scientific, construction enables us to make these torches for the highest grade of service at about the same price for which ordinary apparatus is sold.

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The Quality Is Not Allowed To Vary

Dixon's Graphite Rods and Plates for Welding

Made in all diameters, lengths and sizes.

Small diameter rods are sold in 4, 6 and 8 inch lengths, the shorter the rod the less breakage in shipping.

Also Dixon's Graphite Welding Putty. In 5 and 10 lb. cans.

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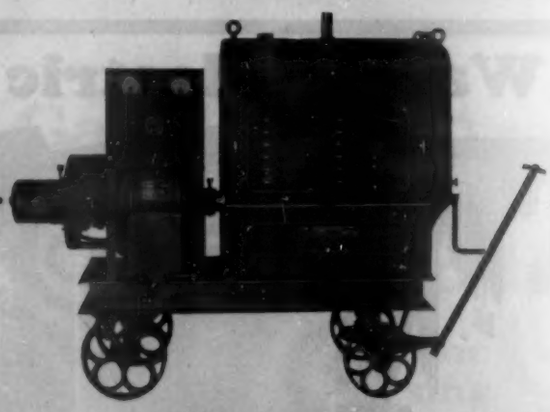

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This is our 200-300 Ampere Welder, driven by a 1450 R.P.M., 4 cylinder Wakesha Gas Engine. It will stand up to full load on continuous service, without overheating. Steady work, with a steady arc. We have improved the welding arc by getting rid of external stabilizing devices.

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Welding Wire *and* Electrodes

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To assure perfect results all Page Welding Wire and Electrodes are carefully treated and drawn especially for the type of work for which they are recommended. They are always uniform.

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In addition each type of Page Welding Wire is shop tested at frequent intervals under actual shop conditions to insure its high welding qualities.

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For Every Oxy-Acetylene Welding and Cutting Job

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Save 2 to 5 Cents per Cubic Foot of Acetylene

The Imperial Acetylene Generator provides a constant supply of pure acetylene gas at a saving of 2 to 5 cents per cubic foot over gas compressed in cylinders. Approved by the Underwriters Laboratories. No weights, pulleys or motors. Send for complete description.

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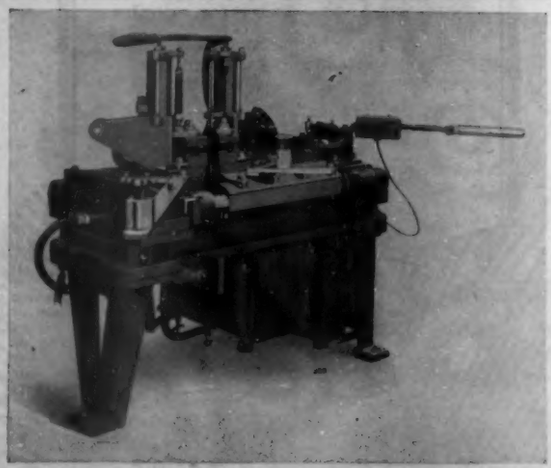
We produce all types of electric spot, butt and seam welders, standard or special, whichever is desired.,

Offices in all the large cities and if not listed in your telephone directory, write us direct.



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Designed and equipped for welding steel tubing and windshield frame. Supplied with air operated clamps and automatic cutout for rapid production of duplicate parts..

Air pressure required not less than 80 lbs. per square inch. Production 300 welds per hour.

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If you dig into facts you will find

lives up to its slogan "More Gas per Pound"—

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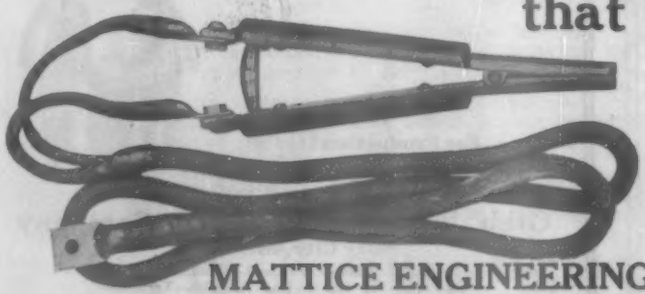
the ONLY Welding Handle—
that EVERY Welder Likes
SIMPLE : : SURE : : STRONG



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The Ideal Glove for Electric and Acetylene Welders is made from Sheep Skin, which has been Subjected to an Asbestos Treatment and which makes it both heat resisting and fireproof.

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The Ideal Apron for Welders is made of leather which has been especially treated to stand the heat, and at the same time be very flexible and durable.

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Single Operator and Two Operator Machines

for electric motor, gasoline engine or belt drive and for either stationary or portable service

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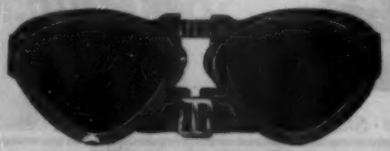

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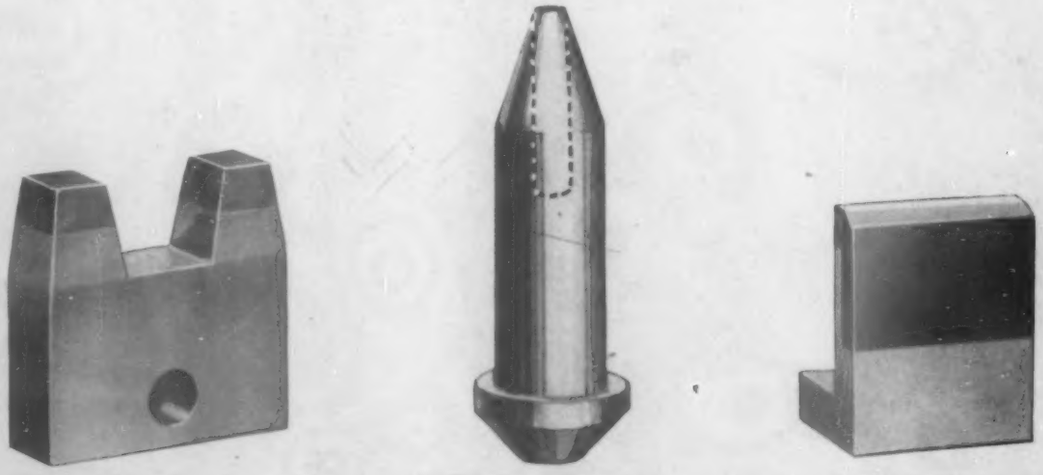

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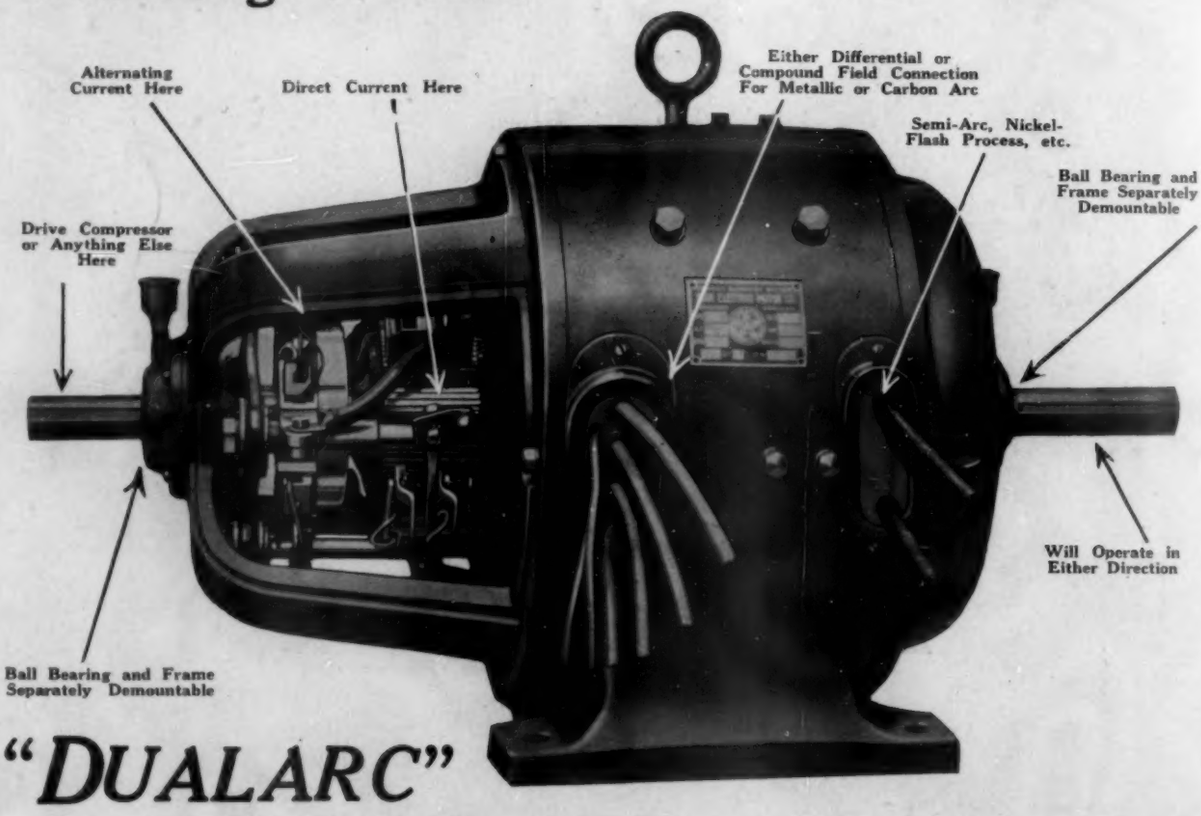
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